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### ANTOINE Céline, MÜLLER Jessica & CASTELLA Emmanuel

Laboratoire d'Ecologie et de Biologie Aquatique; Université de Genève; chemin des Clochettes 18; CH-1206 Genève; Switzerland

#### Assemblages of freshwater molluscs in a fringing wetland (Lake Neuchâtel, Switzerland)

Freshwater gastropod assemblages were surveyed in 9 contrasted ponds of the largest Swiss wetland (fringe of Lake Neuchâtel). The survey was carried out as a preliminary assessment of molluscan biodiversity in ponds selected along gradients of age and hydrological connections. It is intended as a basis for 1) selection of sites for monitoring of the dynamics of key species, and 2) prioritising management options aiming at biodiversity preservation/enhancement. Over 22 taxa were recorded among which *Valvata macrostoma* and *Bathymophalus contortus* (L.) are of prominent interest. Relationships between habitat types, water/sediment characteristics, molluscan diversity and species composition are discussed.

### ARNOLD Claire, GILLET François & GOBAT Jean-Michel

University of Neuchâtel; Institute of Botany; Laboratoire d'écologie végétale; rue Emile-Argand 11; CH-2007 Neuchâtel; Switzerland

#### Ecological knowledge and species conservation: the example of the European wild grapevine *Vitis vinifera* subsp. *sylvestris* (Gmel.) Hegi

Since the beginning of the century there has been a very marked decrease of wild grapevine in Europe, resulting in the fragmentation of its distribution area. This reduction of the populations is directly or indirectly linked to human activities and to a lack of knowledge of this subspecies. From an historical point of view, the discovery of typical wild grapevine seeds in Neolithic sites shows that this subspecies is anterior to subspontaneous cultivars on the European territory. New genetical molecular technologies based on microsatellites show the presence of alleles specific to wild grapevine, which prove the originality of subsp. *sylvestris*. The ecological study of wild grapevine highlights both the necessary natural conditions for maintaining population dynamics, and the dangers which threaten it. Seedlings and young plants were observed in only 11% of the 163 studied stations. This established fact leads us to suppose that present conditions are no longer propitious to regeneration in a majority of sites whose permanence is endangered. All attempts at reintroduction in the Rhine floodplain forests have so far been unsuccessful. Precise studies of active regeneration stations should make it possible to define the optimum conditions for site revitalisation or for the successful reintroduction of wild grapevine in stations where it existed in the past.

### BAER Boris<sup>1</sup>, MAILE Roland<sup>2</sup>, SCHMID-HEMPER Paul<sup>1</sup>, MORGAN E. David<sup>2</sup> & JONES Graeme R.<sup>2</sup>

<sup>1</sup> Experimental Ecology; ETH Zürich; Switzerland

<sup>2</sup> Keele University; Chemistry Department; Keele Staffordshire; United Kingdom

#### Chemistry and possible function of a mating plug in bumblebees

Previous work showed that queens of the bumblebee *Bombus terrestris* would benefit from multiple mating due to lower parasite load and higher fitness. Nevertheless, *B. terrestris* is mostly singly mated in Central Europe. One possible solution to this phenomena is that the male bumblebee does not want to share its fitness with other males and therefore prevents multiple mating by transferring a sticky plug into the queen's sexual tract. Chemical compounds in

the plug may influence the queen's behaviour, i.e. perhaps preventing her from mating again ? Using gas chromatography we identified cyclo-prolylproline and 4 different fatty acids present in the plug. We then mixed the same concentration of these compounds to create a "synthetic plug". This will enable us to test effects of these chemicals on male and queen mating behaviour.

### **BAER Boris & SCHMID-HEMPEL Paul**

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#### **Multiple mating: an advantage against parasites**

Multiple mating by males (polyandry) and females (polygyny) is common in animal species. Whereas the advantages for males are obvious, the reasons for a female to mate several times are more difficult to understand. In social insects multiple mating by males and females reduces relatedness within colonies and thus is problematic for a kin selection explanation for the maintenance of eusociality. Nevertheless, multiple mating is common in social insects and several hypothesis have been proposed to explain this fact. One of them states that multiple mating increases genetic variability providing an advantage against parasites. We tested this hypothesis using the bumblebee *Bombus terrestris* (L.). Using artificial insemination, we were able to produce bumblebee colonies of high and low genetic diversity. These colonies were placed in the field and worker samples were collected and checked for the presence of parasites. For the two most common parasites, *Crithidia bombi* and *Nosema bombi*, we found that intensities and prevalence were lower in colonies of high genetic diversity than in colonies of low genetic diversity. Additionally, for all parasite species found, parasite load and parasite richness were significantly lower in colonies of high genetic diversity than in colonies of low genetic diversity. Finally, the fitness of colonies of low genetic diversity was lower. These results show that queens benefit from multiple mating with respect to parasitism and fitness. The fact that *B. terrestris* is singly mated in central Europe may be explained by the mating behaviour of the male, which includes mate guarding and the production of a sticky mating plug injected into the female after sperm transfer.

### **BOLLENS Ursula & RYSER Peter**

Geobotanisches Institut ETH; Zürichbergstrasse 38; CH-8044 Zürich; Switzerland

#### **Nutrients and water regime: Effects on 16 wetland species**

Although protected by law, Swiss wetlands suffer damage from nutrient inflow and interference to the water regime. Because species diversity is highest at a rather low level of biomass production, it is an objective of wetland management to lower site productivity. Should we focus mainly on keeping nutrients away from the surroundings or is flooding also an appropriate means to promote typical species composition ?

To test the response of various fen species to different nutrient availabilities and water levels, a factorial growth experiment was established in spring 1998. The treatments are: base-level fertilisation (0.9 mg N/individual/week, 0.06 mg P/individual/week), threefold nitrogen supply, threefold phosphorus supply; wet conditions, flood periods, and drought periods. Biomass and nutrient content were recorded in September 1998.

The first season's results show a distinct rise of biomass due to additional nitrogen fertilisation and only little effect of the phosphorus treatment. These results apply to all species whether they originate from nutrient poor or nutrient rich sites. Even under enhanced nitrogen supply there is little evidence of phosphorus limitation. All species are affected by flood. Periodic drought causes negative or positive effects on biomass production.

Conclusions: (1) Nitrogen was the growth limiting element in the experiment. The growth reducing effect of flooding was probably due to its reducing effect on N-uptake. (2) The results suggest that flooding is an appropriate means of reducing site productivity. However, the water

used for flooding should not be nitrogen rich. (3) One growing season is too short for the assessment of species-specific effects of nutrients and flooding. The experiment will be continued for another year.

### **BRASCHLER Brigitte**

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#### **Influences of small-scale habitat fragmentation on ants**

In many parts of the world, human activities have greatly altered natural landscapes, converting them in mosaics of agricultural, industrial and urban patches. Habitat fragmentation is one of the most apparent consequences of human use of nature. Research has often focused on large-scale habitat fragmentation and its effects on conspicuous species groups like mammals and birds. The influence of small-scale habitat fragmentation on less conspicuous species groups, including many small invertebrates, is less studied. In my work I concentrate on the ant populations in calcareous grasslands in the Swiss Jura Mountains. I especially study influences of the fragmentation on species composition, nest dispersion and changes in interactions between colonies and between the ants and other organisms. Several aspects of foraging behaviour of ants seem to be changed in fragments compared to control plots. For example ants were more numerous at baits in fragments than at baits in control plots. Also ants preferred to forage on baits in the fragment rather than in the surrounding isolation area. Additionally, aphids, an important sugar resource of many ant species, were more abundant in fragments than in control plots. Effects on nest dispersion and species composition are less pronounced.

### **BREM Dominik & LEUCHTMANN Adrian**

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#### **Transmission mode of a grass endophyte with mixed strategy of reproduction**

*Epichloe sylvatica* (Ascomycota, Clavicipitaceae) is a host specific endophyte of the woodland grass *Brachypodium sylvaticum* with two alternative modes of reproduction. The predominant asexual forms are seed transmitted (vertical), whereas the sexual forms are capable of contagious transmission (horizontal) mediated by ascospores. However, transmission rate and mechanisms of infections are undetermined in this system. A transplant experiment and phenological observations were designed to estimate the rate of horizontal transmission and to explore possible routes of new infections. We observed clear coincidence of time of host flowering and availability of ascospores indicating that infection through stigmata is a possible mechanism of horizontal transmission. At sites where sexual forms of *E. sylvatica* were present 34% or 17% respectively, of the uninfected transplants became infected after two years, whereas at sites with only asexual forms all transplants remained uninfected. This suggests that contagious spread of the endophyte to established plants can occur frequently and that ascospores probably serve as inoculum. Besides the stigmata, stem or leaf tissues may provide an alternative route of entry, which can lead to new infections.

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Physical habitat and zoobenthic diversity of a glacial stream (the Mutt, Swiss Alps)



Within the framework of a European research programme for "Arctic and Alpine Stream Ecosystem Research", studies of the geomorphology, water physico-chemistry and macro-benthic communities were carried out in 1996 and 1997 on the Mutt, a glacier-fed tributary of the Rhone River (Switzerland). The objective of the programme is to test and refine Milner and Petts' model (1994) suggesting water temperature and channel stability as the main variables determining the occurrence and longitudinal succession of invertebrate taxa in glacial streams. Diversity and community composition patterns recorded on the Mutt, with sites ranging from 2600 to 1800 m a.s.l., are confronted with the model. Results evidencing high taxonomic richness for groups like Diptera Chironomidae and Trichoptera Limnephilidae are discussed, together with the current relative low level of taxonomic expertise regarding these groups in alpine ecosystems.

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Using species pool and digitised biological data for biodiversity assessment and conservation: a test case with Syrphidae (Diptera)

An overview is given of the use of digitised information about the European species of one group of invertebrates, the Syrphidae (Diptera), in addressing biodiversity maintenance issues. They probably represent no more than 1-2% of Europe's invertebrate biodiversity, so it cannot be claimed that they may be used as proxies for the entire European invertebrate fauna. However, they provide insights into what might be achieved if invertebrates were effectively incorporated into biodiversity maintenance work, rather than being almost universally ignored as at present - although invertebrates do represent approximately 75% of the biodiversity supported by the European continent. The species pool concept is essentially that the biota of part of a region is a sub-set of the biota of that region and so can be predicted from the regional species list, given sets of assembly or deletion rules. In the present case, examples are shown of regional and local syrphid lists, coupled with digitised information on the listed species, invoking the predictive capacity of the regional species pool. The predicted species lists generated are used for assessment of the performance of the biodiversity maintenance function at site level, and for identification of biodiversity maintenance priorities at various spatial levels. The information about Syrphid species is extracted from the "Syrph the Net" database covering some 400 syrphid species known from Atlantic parts of Europe and including spreadsheet files providing information on the habitats, microhabitats, traits, range and status of the included species.

**CASTELLA Vincent, RUEDI Manuel, EXCOFFIER Laurent & IBANEZ Carlos**

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Do males and females mouse-eared bats cross the Gibraltar Strait? Molecular markers say no!

Because of their role in limiting gene flow, geographic barriers like mountains or seas often coincide with large genetic discontinuities. Although the Strait of Gibraltar represents such a potential barrier for terrestrial organisms, no studies have been conducted on its impact on gene flow. Here we test this effect on a flying mammal (*Myotis myotis*) which is distributed on both sides of this Strait. Based on a sample of four populations, mtDNA haplotypes reveal a complete and ancient isolation between Northern and Southern bats. Results based on seven



microsatellite loci confirm the presence of this strong barrier to gene flow, suggesting that neither males nor females do actually cross the 15 km of the Gibraltar Strait. This conclusion is surprising since Mouse-eared bats are able to cover daily up to 25 km between roosts and foraging territories. Several alternative explanations to this surprising pattern of genetic divergence are discussed.

### **DI GIULIO Manuela, EDWARDS Peter J. & MEISTER Erhard**

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#### **Enhancing insect diversity in agricultural grasslands: the role of management and landscape structure**

During the last two decades great efforts have been made in Switzerland to preserve and enhance biodiversity. In this context we are interested in the effects of different management systems and landscape structure on the insect diversity of agricultural grasslands.

The research area is located in the Schaffhauser Randen (Jura formation). It is an extensive forested area with a number of more or less isolated enclaves of agricultural land. Four such enclaves have been selected in order to provide areas with varying mixtures of arable and grassland habitats. In each enclave (area), meadows of two grassland management types ('medium intensive' and 'extensive') have been investigated. As an indicator group for insect diversity true bugs (Heteroptera) were chosen. Previous studies have shown that the richness of the bug fauna correlates strongly with total insect diversity.

The bug communities of extensive sites demonstrate clearly a more even rank abundance distribution compared to those of medium intensive sites. Extensive meadows have both more individuals and more species.

We used ordination techniques to assess the factors affecting the structure of bug communities. A statistical method based on Canonical Correspondence Analysis (Borcard 1992) was used to partition the variance of the species data into spatial (area) and management components. Our model explains 72.3% of the variance ( $p=0.01$ ). Management accounts for 29.7% ( $p=0.01$ ), area for 35.4% ( $p=0.01$ ) and the interaction 'management x area' for 7.2% of the species variation.

### **DIETRICH Barbara & WEHNER Rüdiger**

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#### **Coexistence of parapatric species: how do desert ants solve this contradiction ?**

The parapatric *Cataglyphis*-species, *bicolor* and *savignyi* inhabit different parts of the lowland/highland steppes of central Tunisia and the presaharan semidesert of southern Tunisia, respectively. Due to their morphological similarity these two species have been mistaken as one single species since the beginning of this century. Within the study area both species overlap in their distributional ranges. The temporal and spatial foraging patterns of the two *Cataglyphis* species were investigated particularly in the steppe area around the oasis of El Guettar in central Tunisia. By recording the ants foraging paths we showed that *C. bicolor* exhibits significantly shorter foraging runs than *C. savignyi* with respect to both length and time: 90% of the foraging time is spent within an area of radius 14.5 m and 21.0 m, respectively (Mann-Whitney U-test:  $p = 0.014$  (length),  $p = 0.038$  (time)). This result is in accord with the outcome of geobotanical studies of the nesting sites. We were able to demonstrate that they exhibit clear-cut microhabitat differences. *C. bicolor* colonies usually occupy the more plentiful micro-habitats than *C. savignyi*. Furthermore experiments with artificial food baits showed that *C. bicolor* dominates *C. savignyi* in direct encounters. These results suggest that coexistence is maintained by the interrelationship of the two species: the dominant species drives the subordinate one out of the higher quality microhabitats.

**FINKELDEY Reiner**

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**Molecular markers and the conservation of forest resources - is there an impact ?**

During the last decade a rapidly increasing number of molecular genetic markers was successfully applied to forest trees. The urgent need to conserve forest genetic resources has often motivated this research. However, the practical impact of most molecular genetic studies is negligible. At least three main reasons account for this situation: first, research has concentrated on a few widespread, common tree taxa of the temperate and boreal zone (in Europe mainly *Picea*, *Pinus* and *Quercus* species), although the need for conservation measures is most urgent for endemic, rare species of the tropics. Second, research focused on an investigation of spatial patterns of genetic variation at marker loci without straightforward implications for patterns of adaptive variation. Third, new molecular techniques have shifted research priorities from problem-orientation towards method-orientation. Researchers tend to concentrate on the development and validation of new marker types rather than on the application of existing tools to urgent conservation problems. Biochemical and molecular markers have the potential to contribute significantly to the conservation of forest resources if they are used to investigate key processes in endangered forest ecosystems. This implies their application in a population genetic context, their combination with other investigations including ecological field observations and quantitative genetic experiments, and a focus on both spatial and temporal dynamics of genetic structures. A recently published study on the reproduction and gene flow of tropical figs (*Ficus* spp.) based on allozyme markers illustrates the usefulness of gene markers in this regard.

**FISCHER Markus, VAN KLEUNEN Mark & SCHMID Bernhard**

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**Relations among population size, genetic variation, and plant performance: the example of *Ranunculus reptans***

Firstly, we studied selectively neutral RAPD-variation in samples representing comparable areas of 17 populations (3 at Lake Como, 14 at Lake Constance) of the clonal *Ranunculus reptans*, a rare lake-shore plant. Variation among populations ( $p < 0.001$ ) corresponds to a low gene flow of  $N_m = 0.84$ . Molecular variance was smaller in small populations covering  $< 100 \text{ m}^2$  area than in larger ones ( $p < 0.03$ ), indicating genetic drift. Secondly, we grew vegetative offspring of 104 genotypes from the 14 Lake Constance populations with and without competition by the grass *Agrostis stolonifera* in a plant room and measured the number of nodes (rooted, flowering, and total) produced per planted rosette. Plants from larger populations produced more nodes than plants from smaller populations (total  $p < 0.03$ ; rooted  $p < 0.1$ ; flowering  $p < 0.01$ ), whereas positive correlations with molecular variance were not statistically significant. Plasticity (mean without competition minus mean with competition) of node numbers was larger for plants from larger populations (significant for total number of nodes) and for plants from populations with higher molecular variance (significant for number of rooted nodes). Non-significant correlations between broad-sense heritabilities and population size respective molecular variance were positive for the numbers of nodes and negative for plasticities therein. Numbers of nodes and plasticity therein were negatively correlated with the corresponding heritabilities. Because we grew plants in controlled environments our study indicates a genetic basis of observed patterns. Because differences among populations were more closely related to population size than to molecular variance they rather indicate effects of selection than of genetic erosion. Directed selection may also explain observed negative correlations between performance measures and corresponding heritabilities. Our study supports the notion that genetics matter for plant conservation.

**FREIMANN Barbara & WARD Paul I.**

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**Male seminal products influence female sperm storage muscles in *Scathophaga stercoraria***

The Yellow dungfly *Scathophaga stercoraria* (L.) is frequently used as a model organism to examine questions about reproductive strategies. In this study we examine the influence of male seminal products on the muscles of the female sperm storage organs, the spermathecae. There are normally three spermathecae, arranged as a singlet and a doublet, which are connected to the bursa copulatrix by long ducts. Isolated female reproductive tracts were treated with different male extracts: from testes, ductus seminalis or as a control, Ringer. It was shown that male testes extracts increase the contraction rate of female spermathecal muscles. There may also be differences between the reactions of singlet and doublets. It is suggested that this mechanism helps to transport sperm into the female spermathecae, as sperm cannot move extensively on their own. The control of muscles responsible for sperm uptake is therefore a "hot spot" in the conflict of interests between male and female in this polygamous fly.

**FREYMOND Hervé & GALLAND Nicole**

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**Genetic diversity and conservation of *Saxifraga hirculus***

*Saxifraga hirculus* L. is a tetraploid arctic-boreal plant species; it has a wide circumpolar distribution, whereas its distribution outside Polar regions is highly fragmented. In Switzerland, *Saxifraga hirculus* was known to occur in at least 25 localities but now only occurs in one locality (Col du Marchairuz, VD, the southernmost European population of this species). As a consequence of such fragmented distribution and of restricted gene flow, genetic drift and inbreeding may occur in the relic populations. Thus, in a conservation perspective, we have addressed three major questions: 1) What is the level of genetic diversity within and among populations ? 2) Is there a spatial genetic structure within populations, and if so, what is the size of the breeding units ? 3) How critical is the vegetative reproduction versus sexual one ? For this purpose, a survey of allozymes/AFLPs diversity of six populations (from Switzerland, Denmark and Iceland) is being undertaken. Methodology and sampling scheme are presented, with the advantages and limits of allozymes and AFLPs. The results of this study will help in designing conservation plans in the future.

**FUMAGALLI Luca & TABERLET Pierre**

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**Genetic affiliation of historical wolves from Switzerland**

Human persecution and forest clearance has led to the eradication of wolf *Canis lupus* populations in the Alps in general and in Switzerland in particular before the end of the 19th century, even if few isolated individuals of unknown origin have been killed during the 20th century. The species started to recolonize this region from the Italian population in the early 1990s and this process is still going on. We have sequenced a portion of the mitochondrial DNA control region from three historical samples: one individual from a Middle Age site, and two individuals killed in 1947 and 1954, respectively. The mitochondrial data can be useful to characterise whether the population presently colonising the Alps corresponds to the historical lineage disappeared from Switzerland. The analysis reveals that: (1) the DNA sequence from



the Middle Age sample is closely related to a wolf mitochondrial lineage found in Central Europe; (2) the two individuals killed in Switzerland during this century show a mtDNA haplotype typical of North American wolf populations. Conservation implications of these results are discussed.

**GALEUCHET David J., RUTISHAUSER Rolf & SCHNELLER Johann Jakob**

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*Typha minima* - formerly common, now endangered. Genetic variability and relationship between fragmented and ex situ populations

In Europe *Typha minima*, a pioneer plant in alluvial zones of alpine rivers, has become endangered. During the last decades the number of populations strongly decreased due to loss of natural habitats. We asked the following questions: Which consequences has fragmentation on the genetic variability of *Typha minima*? What are the consequences for the conservation? Our results showed that in spite of strong fragmentation no genetic drift was detected along the river Rhine. This might be due to the fact that fragmentation of populations took place only recently and/or to clonal growth of the species. Gene flow may be still possible by water transport (seeds) downstream. However, the distance between populations seems to be too far for effective wind dispersal (pollen, seed). To preserve *T. minima* from extinction and to rebuild a functional metapopulation along the river Rhine it is necessary to reintroduce plants from ex situ populations. A reintroduction into the Rhone valley is questionable, because the ex situ populations in the botanical gardens of Fribourg and Geneva are not known.

**GANTENBEIN Benjamin, LARGIADER Carlo R. & SCHOLL Adolf**

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Nuclear and mitochondrial gene variation among populations of *Buthus occitanus* (Amoreux, 1789) across the Strait of Gibraltar

We analyzed population samples of *Buthus occitanus* (Amoreux, 1789) (Scorpiones: Buthidae) across the Strait of Gibraltar using allozyme electrophoresis (15 loci scored) and sequencing a 460 bp fragment of the 16S rRNA mitochondrial gene. The samples were collected from three sites in Spain and France (ssp. *occitanus*), eleven sites in Morocco (ssp. *occitanus*, ssp. *mardochei* and ssp. *paris*) and one site in Tunisia (ssp. *tunetanus*). Also, *B. atlantis* from five sites along the Atlantic coast of Morocco were included, this taxon was alternatively treated as a subspecies of *B. occitanus*. A sample of *Androctonus mauretanicus* (Pocock, 1902) from Morocco and a sample of *Androctonus crassicauda* (Olivier, 1807) from Turkey were included as outgroups in the allozyme analysis. *Centruroides exilicauda* (Wood, 1863) from Baja California was the outgroup for DNA sequence analysis. Generally, the observed genetic variability of allozymes was low within populations. The UPGMA phenogram, based on Nei's D (1972), shows a low genetic differentiation among all *Buthus* samples from Morocco (including *B. atlantis*). *B. o. occitanus* from Europe and *B. o. tunetanus*, however, clearly branch off at a high genetic distance. In contrast to the allozymes, the mtDNA data revealed more differentiation among the Moroccan samples, showing several lineages. The divergence among these lineages is about the same as between populations separated by the Strait of Gibraltar (approximately 12% sequence divergence).

**GAUTSCHI Barbara & TENZER Isabel**

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### Development of microsatellite markers for the Bearded Vulture (*Gypaetus barbatus*) and their application to the reintroduction project

We describe the construction of a genomic library of *G. barbatus* enriched for the simple sequence repeats (CA)<sub>n</sub> and (GA)<sub>n</sub>, respectively. We found 29 different microsatellite repeats in 62 positive clones sequenced. So far, unique primer pairs for 16 of these 29 loci could be designed. Eleven primer pairs amplified in a locus specific manner. We describe the characteristics of these microsatellite markers and present preliminary results of polymorphism. The use of these newly developed microsatellite markers for the reintroduction project will be discussed.

**GEBHARDT-HENRICH SABINE**

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### Reproductive success was predicted by body mass loss in female great tits (*Parus major*)

Body mass changes between incubation and when nestlings were 14 days old were measured in a great tit population breeding in artificial nestboxes. Half of the pairs were experimentally fed from nestbuilding until the hatching day of their young. Females lost 1.82 g (STD: 1.15, N = 67) between incubation and when their nestlings were 14 days old. Mass loss was not affected by experimental feeding. In control (unfed) females fledgling mass was significantly negatively correlated with body mass loss of the females. Under additional feeding this relationship tended to disappear. Fledgling mass is a predictor of fledgling survival in tit species and thus a measure of reproductive success. Fledgling number was not correlated with loss of body mass. Therefore, females losing less body mass during breeding had a higher current reproductive success than females with a greater loss of body mass.

**GERLOFF Christine U., OTTMER Birgit K. & SCHMID-HEMPEL Paul**

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### Inbreeding in bumble bees

In small and isolated populations low levels of genetic variation may increase the likelihood of inbreeding, leading to inbreeding depression. In addition to more general negative effects, inbreeding in social hymenoptera leads to the production of diploid males. These males develop from eggs that should have produced workers or young queens but instead develop into diploid males because they are homozygous at the sex determining locus. The production of diploid males is very costly for the colony because it decreases the work force by 50%, and furthermore, the diploid males do not sire viable colonies. We studied the effect of inbreeding on the performance of colonies of the bumble bee *Bombus terrestris* (L.). We compared colonies of queens mated to their brother to those mated to an unrelated male (33 inbred and 44 outbred colonies out of 16 maternal families). We scored the number of workers and sexuals produced and calculated the caloric investment into sexuals to estimate fitness at the colony level. At the level of the individual we measured the efficiency of immune defences. The results show that inbreeding has no consistent negative effect but that the effect depends on the genetic background of the family and the colony. Diploid males had significantly lower immune defences than haploid males. Thus, when assessing the effects of inbreeding in a population, its genetic structure has to be considered.

**GOUDET Jérôme**

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### A population genetics view of multivariate statistical methods

While multivariate statistics are appealing to the population geneticist, they suffer from two drawbacks. The first is the lack of correspondence between inertia and a genetic parameter. The second is the absence of good testing procedure. Here I identify the relation between inertia and  $F_{st}$ , and suggest a test for both total inertia and the inertia of the different axes. The analyses are applied to both simulated and real data sets. Advantages and limits of multivariate methods are discussed.

### GOINGUENE Sandrine, DEGEN Thomas & TURLINGS Ted

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#### How parasitoids of caterpillars find suitable hosts ?

Many parasitoids that attack phytophagous insects make use of plant odours to locate the habitat of their hosts. These odours are specifically emitted by a plant after it has been damaged by a herbivore, and not after mechanical damage. The odour emissions occur systemically throughout the plant. Factors in the oral secretion of the herbivores are the main elicitors of the plants' reaction. One such elicitor, volicitin, was recently isolated and identified. The induced plant odours are useful cues for the parasitoids and indicate the presence of a potential host. Studies on these volatile plant signals have been conducted most extensively with maize plants and have led to the exact identification of the blend of compounds (mainly terpenoids) that is emitted after caterpillar attack. Our recent studies show that plants of a single maize variety consistently emit similar odour blends, but there can be considerable variation among different maize genotypes. This variation is also observed in the emissions of wild relatives of maize. We discuss these results in the context of the reliability of plant-induced signals as cues that allow parasitic wasps to find suitable hosts.

### GOVERDE Marcel, BAZIN Alain, SHYKOFF Jacqui & ERHARDT Andreas

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#### Influence of leaf chemistry of *Lotus corniculatus* (Fabaceae) on larval development of *Polyommatus icarus* (Lepidoptera, Lycaenidae): effects of elevated CO<sub>2</sub> and plant genotype

1) Four *Lotus corniculatus* genotypes differing in their cyanoglycoside and condensed tannin concentrations were grown in either low (350 ppm) or high (700 ppm) atmospheric CO<sub>2</sub> environments. Larval performance, consumption and conversion efficiency of *Polyommatus icarus* feeding on this plant material was measured. 2) Plants grown under elevated CO<sub>2</sub> contained less cyanoglycosides, more condensed tannins and more starch than control plants. However, water content, nitrogen and protein as well as the nitrogen content in relation to carbon concentration did not differ between CO<sub>2</sub> treatments. 3) The four genotypes differed significantly in condensed tannins, cyanoglucoside, leaf water and leaf nitrogen but no genotype x CO<sub>2</sub> interaction was detected, except for total phenolics and condensed tannins in which two plant genotypes showed stronger increases under elevated CO<sub>2</sub> than the other two. 4) Larvae of *P. icarus* consumed more plant material and used and converted it more efficiently from plants grown at high atmospheric CO<sub>2</sub>. 5) Larvae developed significantly faster and were significantly heavier when fed plant material grown under elevated CO<sub>2</sub>. The observed difference in weight disappeared in the pupal and adult stages. However, lipid concentration of adults from the elevated CO<sub>2</sub> treatment was marginally significantly higher than of controls. 6) We conclude that the higher carbohydrate content of *L. corniculatus* plants grown at elevated CO<sub>2</sub> renders leaves more suitable and better digestible to *P. icarus*. Furthermore, differences in allelochemicals might influence the palatability of *L. corniculatus* leaves for this specialist on Fabaceae.

**GUGERLI Felix, SPERISEN Christoph, BÜCHLER Urs & SENN Josef**

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**Genetic diversity in tree species of subalpine forests: a case study of Norway spruce (*Picea abies*)**

From a human perspective, one of the predominant tasks of forests in mountainous areas is to protect against natural hazards. Stability of mountain forest stands, however, is increasingly threatened by air pollution, cease of management, lack of regeneration due to overabundant ungulates, and novel environmental conditions because of climate change. The project 'Biodiversity in Alpine Forest Ecosystems: Analysis, Protection and Management', funded by the European Union, addresses the genetic diversity of carrier species in Alpine forest ecosystems. The overall objective of the project is to create a common data pool which will help to better understand the function and dynamics of forest ecosystems and to transfer results into practice. At 14 locations across the Alps, each consisting of three elevational levels, populations of adult and juvenile forest tree species are sampled. The target species are *Abies alba*, *Larix decidua*, *Picea abies*, *Pinus cembra*, and *P. mugo*. Nuclear (isoenzymes, microsatellites) as well as plastid markers (chloroplast microsatellites, mitochondrial tandem repeats) are investigated by respective expert groups. Our group so far screened 25 populations of Norway spruce (*Picea abies* (L.) Karst.) for a length polymorphism in the mitochondrial fragment of a *nad1* intron. We found a decrease of within-population variation from eastern to western populations, which we relate to a serious bottleneck during re-colonization of the Alpine range by Norway spruce.

**GÜSEWELL Sabine**

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**Does the public support restoration measures in fen meadows invaded by common reed ?**

Public support is indispensable to the long-term success of measures for nature conservation and restoration. Such measures are more likely to be approved if their aims are understandable and if they are considered useful by the general public; aesthetical aspects might be particularly important in strongly frequented areas. This study investigated whether the invasion of fen meadows by common reed (*Phragmites australis*) is perceived as a degradation by the general public and whether measures to restore lower, more open vegetation types are supported. Qualitative interviews were carried out in the field with visitors of a wetland nature reserve (Robenhauser Ried/ZH); moreover, students of various disciplines answered a questionnaire based on colour photographs. The field survey revealed no general preference for sites with either a high or a low abundance of *Phragmites*. In the questionnaire survey, the tendency to prefer fen meadows with a low abundance of *P. australis* differed among disciplines and increased with the (presumable) knowledge of students about nature conservation. Likewise, the acceptance of restoration measures appeared to mainly depend on ecological knowledge. Both surveys suggested that people reject restoration measures (regardless of their aesthetical evaluation) if they can not conceive (a) that fen meadows are semi-natural areas needing management, (b) that the spread of *P. australis* might be a consequence of human impacts and (c) that changes in management can be necessary to maintain a status quo. More information about these points would probably enhance public support to nature conservation and restoration.

**HAGGSTRÖM Hakan<sup>1</sup>, RAHIER Martine<sup>1</sup> & HARTMANN Thomas<sup>2</sup>**

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### Deterrent effect of pyrrolizidine alkaloids and detoxification by a generalist predator (*Mitopus morio*)

Several leaf beetles in the genus *Oreina* sequester pyrrolizidine alkaloid N-oxides (PAs) from their host plants (e.g. *Adenostyles* spp., Asteraceae). We studied the efficiency of these compounds as defence against a harvestman (*Mitopus morio*, Phalangidae) which is common in habitats where *Oreina* spp. occur. *M. morio* was observed to feed on larvae of *O. speciosissima* and *O. cacaliae* both in the field and in a laboratory experiment. Two populations of *M. morio* were compared with respect to the deterrent effect of PAs and the efficiency of detoxification. One of the populations comes from a site dominated by *Adenostyles alliariae*. These individuals are likely to have come into contact with prey containing PAs. The other population comes from a site where *Adenostyles* spp. are absent and is therefore likely to have little experience of PAs. For the test of deterrence, the individuals were offered artificial food (minced meat) containing the PA senecionine N-oxide in different concentrations. The efficiency of PA detoxification was studied in a tracer feeding experiment. The two populations differed in both behaviour and detoxification ability. Individuals from the population lacking *Adenostyles* plants were more deterred by the alkaloid compared to those from the other site. The metabolic treatment of PAs differed between the populations, but both populations had efficient ways to eliminate PAs and did not sequester these compounds for their own defence. We suggest that the efficiency of PAs as defence for sequestering herbivores may differ between populations.

#### HEEB Philipp

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### Within-pair copulation frequency predicts female reproductive performance in tree sparrows, *Passer montanus*

Female birds can solicit and accept copulations from males and are thus able to control their copulation frequency. Engaging in copulations is expected to be costly since copulations take up time and can increase the risks of predation and pathogen transmission. Given these costs, the high frequency of within-pair copulations shown by many monogamous birds remains puzzling. A number of hypotheses have been proposed to explain the benefits that female birds obtain from frequent copulations with their male. These non-exclusive hypotheses predict that high within-pair copulation frequencies should be positively associated with components of female reproductive performance. In agreement with this prediction results from a tree sparrows population show that within-pair copulation frequency was positively correlated with the number of eggs laid and the number of young raised. The results suggest that, in tree sparrows, within-pair copulation frequency can be considered as an early expression of the pairs' reproductive ability. The possibility that within-pair copulation frequency could function as a signal for assessment of phenotypic quality by both males and females is discussed.

#### HELLRIEGEL Barbara<sup>1</sup> & REYER Heinz-Ulrich<sup>2</sup>

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### Which factors influence the composition of mixed populations of a hemiclinal hybrid (*Rana esculenta*) and its sexual host ?

Hemiclinal hybrids combine advantages of sexual and asexual reproduction, but their need for backcrossing tightly couples their population dynamics with that of their sexual hosts. Two discrete-time models are constructed to identify important factors influencing the composition and dynamics of the resulting mixed populations. Hybridogenetic waterfrogs serve as an



example. The results can explain the remarkable stability over time of observed species ratios within hybridogenetic populations, even when population sizes fluctuate. They also make suggestions why species ratios vary so widely between populations: the precondition is that either one or several of the four factors mate choice, relative fecundities, (larval) competitive abilities, dispersal and their interactions differ among localities. While differences in fecundity influence species coexistence, larval superiority seems to be more important for the hybrids spread in mixed populations; but differences between host and hybrid are not necessary for their coexistence. Dispersal affects the species composition mainly in the habitat where host and hybrid are competitively equal, but ecological and reproductive dispersal have opposing effects. These results suggest interesting consequences for other tightly coupled systems.

**HERGER Franziska, LARGIADER Carlo R., LÜRTSCHER Mathias & SCHOLL Adolf**

Division of Population Biology; Institute of Zoology; University of Bern; Baltzerstrasse 3; CH-3012 Bern; Switzerland

**The *Austropotamobius pallipes* species complex in the Alpine region - phylogeographic studies using nuclear and mitochondrial markers**

In a joint analysis of nuclear (allozyme) and mitochondrial markers (sequence and RFLP analysis) five genetically distinct groups of the *Austropotamobius pallipes* (Lereboullet 1858) species complex were detected in the Alpine region. The geographic distribution of these evolutionary lineages coincided largely with several taxa (*A. p. pallipes*, *A. berndhauseri*, *A. p. italicus*) defined on the basis of morphological characters. A low level of genetic variability was found within these lineages. In some cases, the combination of the two marker classes allowed to assess the natural or artificial origin of populations. The interlocking distribution of the five evolutionary lineages indicated that conservation efforts must aim at the level of local populations.

**HEYLAND Andreas**

Zoological Museum; University of Zurich; Winterthurerstrasse 190; CH-8057 Zürich; Switzerland

**Behaviour and mutual influencing of two polychaete species with different life-cycles during settlement: *Poecilochaetus serpens* E. Claparede and *Sphaerosyllis* sp. (Polychaeta: Syllidae: Exogoninae)**

The influence of a small interstitial polychaete (*Sphaerosyllis* sp.) on the settlement behaviour of a polychaete with a benthoplanktonic life-cycle (*P. serpens*) was examined in a series of laboratory experiments. *Sphaerosyllis* sp. was found exclusively in the first cm of the sediment and was among the most abundant species at this site, with an average of around 11,000 animals per m<sup>2</sup>. From direct observations of the settlement process of *P. serpens* with a digital camera-system it was found that *Sphaerosyllis* sp. disturbed the settlement behaviour of *P. serpens* planktonic larvae that were in an advanced developmental stage. However this influence was not strong enough to prevent *P. serpens* larvae from settling. *P. serpens* settled immediately on the sediment but a decision to leave the substratum could be made after the animal was partially burrowed. Possible reasons and consequences of this behaviour are discussed. The nearest neighbour distances between settling planktonic *P. serpens* larvae were measured under laboratory conditions. No avoidance behaviour was observed between these larvae, which might explain the patchy distribution of *P. serpens* in the field.

**HOFER Ulrich<sup>1</sup>, BERSIER Louis-Félix<sup>2</sup> & BORCARD Daniel<sup>3</sup>**

<sup>1</sup> Department of Vertebrates; Natural History Museum; Bernastrasse 15; CH-3005 Bern; Switzerland

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### Spatial organization of a tropical forest herpetofauna on an elevational gradient revealed by null model tests

Five null model tests were applied to the herpetofaunal assemblage on the western slope of Mount Kupe, Cameroon. Based on the pattern of species range boundaries and abundances along the primary forest elevational gradient, ranging from 900 to 2,000 m, the relative importance of interspecific competition and ecotones in structuring the assemblage was assessed. Tests were run for 1) all species, 2) amphibians, 3) reptiles, 4) amphibians dependent on streams for reproduction, and 5) amphibians that don't use streams for reproduction. For three null models, the observed patterns do not differ from random expectations. The results indicate that there are very few species whose gradient distributions may be limited by interspecific competition between congeners. Significant discontinuities in abundance patterns and range boundary dispersion revealed zonations in all subsets analyzed, but neither indicate distinct species groups with sharp exclusion boundaries nor a strong response to vegetational ecotones. Physical factors varying in parallel with the gradient and specific habitat components, particularly waterbodies suitable as amphibian breeding sites, are suggested to be the dominant factors in limiting gradient distributions of amphibians and reptiles on Mount Kupe. The zonations revealed suggest a pattern of three spatially non-exclusive species groups: physical factors separate distinct lowland and montane species limited by physiological constraints and produce the faunal discontinuities in the lower submontane forest around 1,300 m; this boundary is encompassed by the range of a group of anuran species, whose distributions on the gradient are centred at intermediate elevation, and appear to be limited by specific habitat requirements. The response to predominantly abiotic factors suggests a basic difference to endotherms, where biotic factors seem to be of major importance in limiting elevational distributions.

### ILG Christiane, CASTELLA Emmanuel & LODS-CROZET Brigitte

Laboratoire d'Ecologie et de Biologie Aquatique; Université de Genève; chemin des Clochettes 18; CH-1206 Genève; Switzerland

### Macroinvertebrate biodiversity in glacial catchment: the rule of water sources and tributaries

Alpine streams remain relatively understudied, regarded as sheltering poor zoobenthic communities, mainly made up of *Diamesa* (Diptera, Chironomidae). If this is true for glacial rivers, at the snout of the glacier, it is not valid for rhithral or krenal segments, snowmelt- or ground-water-fed, that allow relatively diverse communities to develop. The study presented here, illustrates the case of the Mutt (Valais, Swiss Alps). The main channel is typically kryal, fed by glacial meltwater. Its tributaries are glacial outlets or krenal stream ecosystems. These ground-water fed streams show a broad scale of physico-chemical characteristics depending on altitude, geological substratum or season. There is a very strong correlation between environmental variables (temperature, conductivity, turbidity and discharge) and the composition of the macroinvertebrate communities. In the glacial brooks harsh conditions prevail: low water temperature, high turbidity, large diel discharge fluctuations. Never more than 5 taxa, essentially chironomids, were found in each station. On the other hand, the krenal tributaries are inhabited by highly diversified macroinvertebrate communities (up to 20 taxa at one station). These species, most of them belonging to various families of Plecoptera, Ephemeroptera, Trichoptera, Diptera, prevail in rheocrene habitats, characterised by high physico-chemical stability. The habitat heterogeneity, generated by the different water origins, favours the coexistence in a rather small catchment area of diversified macroinvertebrate communities, and plays therefore an important part in the biodiversity of the Mutt basin.

**JENSEN Deborah B.**

Conservation Science Division; The Nature Conservancy; 1815 N. Lynn Street; Arlington, VA 22209; USA

**Conservation by design: the theory and practice of conservation priority setting**

One key challenge in biodiversity conservation is deciding what actions must be taken today, and which can be put off until tomorrow. Not all species nor all places are equally at risk. Over the past two decades conservation biologists have developed practical but rigorous methods for setting priorities for species, sites and even countries or regions. While most agree that biodiversity value and threat are important criteria for priority setting, disagreements on methods of selecting conservation sites abound. This lecture will review the main approaches for conservation priority setting and argue for the systematic design of reserve networks. Current examples of efforts to design reserve networks will be taken from The Nature Conservancy's work in North and South America.

**KALBERER Nicole & RAHIER Martine**

Institut de Zoologie; Université de Neuchâtel; rue Emile-Argand 11; CH-2007 Neuchâtel; Switzerland

**The cost of dispersal by flight in an alpine leaf beetle *Oreina cacaliae* (Coleoptera: Chrysomelidae)**

One part of the population of *Oreina cacaliae* leaves the host plant patches in autumn and flies to overwintering places away from the host plant. The other part of the population overwinters next to the host plant and does not fly. Flying females emerge earlier in the season and start reproducing earlier than their nonflying conspecifics. In 1997 the flyers took advantage of an early start and the fecundity was not significantly reduced compared to the nonflyers although the flyers died earlier. Due to the extremely high mortality in the flyer group in 1998 fecundity was significantly lower compared to the nonflyers. The cost of dispersal by flight seems to be the higher risk of mortality compared to beetles that overwinter next to the host plant and do not engage in flight.

**KELLER Michael, KOLLMANN Johannes & EDWARDS Peter J.**

Geobotanisches Institut; ETH; Zürichbergstrasse 38; CH-8044 Zürich; Switzerland

**Genetic introgression from distant provenances reduces fitness in local weed populations - a case study with species for ecological compensation areas**

Various seed mixtures have been suggested for ecological compensation areas in intensively used farmland. Seed mixtures which contain foreign seed provenances may reduce fitness in local populations due to genetic introgression. 2) This hypothesis was tested with the weed species *Agrostemma githago*, *Papaver rhoeas* and *Silene alba*. Hybrids (F2 backcrosses) between local Swiss plants and English, French, German and Hungarian provenances (plus one French *Papaver* and one US source in *Silene*) were tested in the field for effects on fecundity. Aboveground biomass after one growing season was taken as a measure for fitness under natural environmental conditions. In some cases, survivorship in the field assay and seed mass were determined. The results were compared with the parents, with the F1 and with crossings among other Swiss provenances. 3) Negative outbreeding effects on fecundity were found in all four hybrids of *Papaver* and in the F2 of *Agrostemma* with introgressions by the German provenance, but not in *Silene*. Mortality was slightly higher in the F1 of *Papaver*, and even more in the F2, whereas it was unaffected in the *Silene* hybrids. Seed mass of *Agrostemma* and *Silene* decreased in the F2 compared with the F1. 4) The results are discussed with respect to the use of foreign provenances on agricultural compensation areas and in the context of reinforcement of endangered plant populations. The relevance of the measured fitness components, and long-term effects of genetic introgressions are addressed as well.



**KERY Marc**

Institut für Umweltnaturwissenschaften; Uni Zürich; Winterthurerstrasse 190; CH-8057 Zürich; Switzerland

**Inferring the absence or extinction of a species from a site: a case study with three snake species**

Many animal species are difficult to see and even during visits to known occupied sites no specimen may be detected. For such species local extinction or absence from a site may be difficult to ascertain. However, if we know with what probability a species is detected at any one visit to an occupied site, the number of times that a site has to be visited unsuccessfully, before it can be presumed unoccupied, can be calculated. The probability of detection can be estimated from visits to sites known to be occupied. From 1994 to 1997 I studied the probability of detection in three snake species, *Vipera aspis*, *Coronella austriaca* and *Natrix natrix* at 88 sites in the Jura mountains. In all species, probability of detection was higher in larger populations. There was no effect of the type of habitat nor of the size of a site. Overall, there was a 38%, 13%, and 21% chance per visit to see at least one specimen of *V. aspis*, *C. austriaca* and *N. natrix*, respectively. This translates into 7, 23 and 13 unsuccessful visits, respectively, that are necessary before a site can be assumed unoccupied. Sites whose occupancy status is unknown are most likely occupied by small populations. For them, a minimum of 15, 28, and 35 visits are necessary in *V. aspis*, *C. austriaca* and *N. natrix*, respectively. Hence, to infer the absence of these species, a much larger search effort than usually applied may be necessary. Furthermore, some of the species may be more widespread than hitherto thought.

**KNADEN Markus**

Zoologisches Institut; Universität; Winterthurerstrasse 190; CH-8057 Zürich; Switzerland

**Enemy recognition in the desert ant *Cataglyphis fortis***

Twenty ants of colony A were given into individual encounters with each 10 ants of colony B and C. A mean aggression level was calculated. After these fights 10 ants of colony C were put into colony A where they were killed immediately. In the next day the individual encounters between ants of colony A and B as well as C were repeated. There was an increased aggression level of colony A against C, but not against B. *Cataglyphis* ants seem to be able to recognize ants which have been intruders in the past.

**KÖLLIKER Mathias**

Zoology Department; University of Bern; CH-3032 Hinterkappelen; Switzerland

**Heritability of offspring begging and its co-evolutionary potential with parental feeding behaviour**

Models of parent-offspring conflict predict that the differing evolutionary interests of genes expressed in parents and their dependent offspring lead to an arms race between offspring begging and parental feeding behaviour. In theory, the evolutionary stable resolution varies depending on 1) mating system, 2) offspring relatedness, 3) fitness cost of begging to offspring and 4) fitness cost of parental effort to parents. In the great tit (*Parus major*), male and female parents feed their young to variable relative amounts, offspring relatedness varies among families due to extra-pair paternity and parents seem to make individual trade-off decisions between current and future reproduction. Such within-population variation may lead to the maintenance of a range of conflict resolutions, rather than one single outcome. We investigated this hypothesis using a cross-fostering experiment where sibships were split and transferred in different nests of unrelated parents. The vocal begging performance of individual nestlings was measured under controlled laboratory conditions. The similarity in vocal begging intensity of



siblings growing in different nests was used as an estimate for its heritability. We tested parental response to begging calls using begging-playback experiments. The broad-sense heritability of vocal begging intensity, and the covariation between the biological parent's responsiveness and the offspring's begging behaviour were estimated. Information about heritable variances and covariances in parent-offspring communication may be necessary to understand its evolutionary potential.

### **KOLNAAR Rogier**

Institut de Biologie végétale; Université de Fribourg; rue Albert Gockel 3; CH-1700 Fribourg; Switzerland

#### **Effect of *Puccinia lagenophorae* on competition between *Senecio vulgaris* and *Capsella bursa-pastoris***

The annual plants *Senecio vulgaris* L. and *Capsella bursa-pastoris* (L.) Medic. belong to similar communities occupying ruderal habitats. The host-specific rust fungus *Puccinia lagenophorae* Cooke infects *S. vulgaris* and infection alters the outcome of competition between *S. vulgaris* and *C. bursa-pastoris*. Depending on time of infection, competition is more or less affected. Epidemics of *P. lagenophorae* develop and may infect *S. vulgaris* plants within a population at various times. Can the development of *P. lagenophorae* epidemics be predicted, and thus, the effect of *P. lagenophorae* on plant competition at the population level? In the study presented the effect of temperature on epidemiological parameters of *S. vulgaris* on *P. lagenophorae* was determined. Plants were grown at different temperatures in two experiments. Incidence, latent period and severity were assessed. In one of the experiments, infectious period and spore production were assessed. Velocity of epidemic spread was estimated for plants grown at 10, 16 and 22°C. A temperature effect on latent period was detected in both experiments, whereas a temperature effect on incidence and severity was detected in only one experiment. Latent period increased by decreasing temperature. Spore production curves were fitted using the gamma function. A temperature effect was detected on infectious period and spore production. Data obtained in the study presented were used to estimate velocity of epidemic spread. A temperature effect on velocity was detected. Velocity of epidemic spread was highest on plants grown at 22°C and lowest on plants grown at 10°C.

### **KUENZLER Reto & BAKKER Theo C.M.**

Abt. Verhaltensoekologie; Zoologisches Institut; University of Bern; Wohlenstrasse 50a; CH-3032 Hinterkappelen; Switzerland

#### **A study of multiple female preferences in sticklebacks using computer animations**

The study of multiple mate preferences is handicapped by the impossibility of experimentally manipulating particular traits let alone combinations of traits. Previously used methods such as direct or indirect tests with live animals and video playback techniques can often not get round confounding variables and suffer from non-standardised variance within and between replicates. Choice tests using reality-based computer animations offer a solution because they feature fully controllable virtual animals in a defined surrounding. A 3D-model of a male stickleback was built based on the dimensions and proportions of an average male and its courtship movements were animated. Females were allowed to choose between two virtual males which only differed in the desired ornament(s) and that were presented simultaneously on a high-quality computer display. The female's attention towards animated males correlated positively with their attention towards a real courting male. First results of preference tests will be presented.

### **KUSKE Stefan**

Federal Research Station for Agroecology and Agriculture; CH-8046 Zürich; Switzerland

Does the mass release of the exotic egg parasitoid *Trichogramma brassicae* pose a risk to populations of endemic natural enemies ?

*Lydella thompsoni* Hert. (Diptera, Tachinidae) is a native larval parasitoid of the European Corn Borer and shows parasitism rates up to 50% in Ticino. The first generation of the tachinid develops on hosts in pristine habitats, such as *Archanara* spp. (Lepidoptera, Noctuidae), while the European Corn Borer is the main host for the subsequent generations. Maize seed producers carry out mass releases of the exotic egg parasitoid *Trichogramma brassicae* Bedz. (Hymenoptera, Chalcidoidea) to control the European Corn Borer, which is the key pest of maize in Ticino. These releases coincides with the oviposition period of known spring hosts of *L. thompsoni*. Preliminary studies have shown that a high percentage of *T. brassicae* can disperse from maize fields into pristine habitats in the surroundings where they search and might parasitize alternative hosts, such as *Archanara* spp. The present study investigates the importance of the exotic egg parasitoid *T. brassicae* in displacement processes of the endemic competitor *L. thompsoni*.

### LAWTON John H.

NERC Centre for Population Biology; Imperial College; Silwood Park; Ascot, Berks SL5 7PY; United Kingdom

#### Biodiversity and ecosystem function

Field and laboratory experiments with model plant communities show clear evidence of a reduction in ecosystem processes (for instance productivity and nutrient cycling) with declining plant species richness within any one site. Comparisons made across different sites, however, yield more complex relationships, so that mixing within- and between-site effects is confusing. A robust body of emerging theory underpins and explains these empirical results. This talk will start by reviewing the theory, before briefly summarising the empirical data. I will then go on to present preliminary results from the European-wide BIODEPTH experiment to illustrate the key points. BIODEPTH has simulated the loss of plant species from model, grass/herb communities using identical experimental protocols at eight sites across Europe. The implications of these data and theory for conservation, in the face of the rapid loss of species from many surviving natural and semi-natural habitats, and for more intensely managed ecosystems and landscapes will be discussed. The remaining scientific challenges are: (i) To understand better the mechanism(s) underpinning ecosystem responses to loss of biodiversity. (ii) To distinguish between the role of biodiversity in maintaining ecosystem processes under constant, or benign environmental conditions, and under extreme environmental perturbations. The "insurance hypothesis" predicts that many apparently "redundant species" are essential for maintaining ecosystems under extreme events. (iii) To start to consider the role of animal and microbial diversity in ecosystem processes.

### LUGON-MOULIN Nicolas, BRUNNER Harald, BALLOUX François, GOUDET Jérôme & HAUSSER Jacques

Institut d'Ecologie; Laboratoire de Zoologie et Ecologie Animale; Bâtiment de Biologie; Université de Lausanne; CH-1015 Lausanne-Dorigny; Switzerland

Do riverine barriers, history or introgression shape the genetic structuring of a common shrew (*Sorex araneus*) population ?

The common shrew (*Sorex araneus*) is subdivided into numerous chromosome races. The Valais and Cordon chromosome races meet and hybridize at a mountain river in Les Houches (French Alps). A significant genetic structuring was recently reported among populations found on the Valais side of this hybrid zone. In this paper, a phylogenetic analysis and partial Mantel tests are used to investigate the patterns and causes of this structuring. A total of 185 shrews

were trapped at 12 localities. All individuals were typed for nine microsatellite loci. Although various mountain rivers are found in the study area, riverine barriers are not found to have a significant influence on gene flow. Partial Mantel tests show that our result is due to the influence of the hybrid zone with the Cordon race. The geographic patterns of this structuring are discussed in the context of the contact zone, which appears to extend up to a group of two rivers. The glacier they originate from is known to have cut the Arve valley as recently as 1818. The recent history of this glacier, its moraine and possibly rivers, may therefore be linked to the history of this hybrid zone.

### MACDONALD David

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#### Alien invaders

Introduced alien species are a major factor in conservation. In particular, the American mink has been widely introduced around the world. This has revealed not only major problems for conservation, but also theoretically interesting insights in ecological theory. In Britain, for example, the American mink is largely responsible for a radical decline in the population of water voles. In Eastern Europe the American mink is responsible for the collapse in populations of European mink. These results, and their wider relevance, will be discussed.

### MATTHIES Diethart<sup>1</sup>, BRÄUER Ingo<sup>2</sup>, MAIBOM Wiebke<sup>2</sup> & TSCHARNTKE Teja<sup>2</sup>

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<sup>2</sup> Fachgebiet Agrarökologie; Universität Göttingen; Waldweg 26; D-37073 Göttingen; Germany

#### Population size and risk of extinction in rare plants

In the mid 1980s the distribution and size of populations of endangered plant species in Lower Saxony (N-Germany) were recorded by the conservation authorities. We used these data as the basis for a study of the effects of population size on the probability of survival of local populations in eight rare plant species (*Gentianella germanica*, *G. ciliata*, *Lepidium campestre*, *Melampyrum arvense*, *M. nemorosum*, *Rhinanthus minor*, *R. serotinus* and *Thlaspi perfoliatum*). In 1996 we visited 359 known sites of these plants and recorded whether they still had extant populations. The risk of extinction of local populations was very high. Of the studied populations 28% had become extinct in the 10 years since the last census. Logistic regressions revealed significant negative relationships between population size and risk of extinction in seven of the eight studied species. The form of the relationship and the population size required for 90% probability of survival over 10 years varied strongly among species, suggesting that minimum population sizes required for persistence will vary among plant species.

### MICKASCH Tatjana M.

Zoological Museum of the University of Zurich; Winterthurerstrasse 190; CH-8057 Zürich; Switzerland

#### Is there a relationship between expanding *Orconectes mosus* and decreasing *Austropotamobius pallipes* populations in Switzerland ?

The white-clawed crayfish (*Austropotamobius pallipes*) is considered an endangered species in Switzerland. It is native to the waterbodies of the canton of Berne, Waadt and Wallis, where the American species *Orconectes limosus* occurs too. The first recording of *O. limosus* was 1979 in Lake Biel. Eversince, it expanded its range continuously, and early in 1998 it was found in the river Aare 90 km downstream of Lake Biel. Because of its resistance to crayfish plague (*Aphanomyces astaci*) it is a potential threat to the white-clawed crayfish. The aim of this



poster is to assess the actual and potential threat of *A. pallipes* by *O. limosus*. In summer and fall of 1997, 63 streams were checked and *O. limosus* was found in 17 out of 43 streams draining either into Lake Biel or the river Aare, but not in the remaining streams. *A. pallipes* was found only in 5 out of 20 streams where the species had been recorded since 1990 by local authorities. *O. limosus* was restricted to the immediate surroundings of the rivermouths. The probability of his occurrence was the higher, the wider the stream was and the denser it was in the river or the lake. There is no obvious connection between the decline of native white-clawed crayfish populations and the expansion range of *O. limosus*. Alternative explanations of the decline of the native species are either chemically or organically polluted water entering the streams more or less continuously, or short intervals of high phosphate and nitrate concentrations after heavy rainfall.

### MIKOS Z. Maja & WARD Paul I.

Zoologisches Museum der Universität Zürich; Winterthurerstrasse 190; CH-8057 Zürich, Switzerland

#### Cryptic female choice of male genotype in the yellow dung fly (*Scathophaga stercoraria*)

Sperm competition in the yellow dung fly, (*Scathophaga stercoraria*), has been examined in great detail. Strong male-biased size dimorphism allows male behavioural control over copulation and fertilisation. Recent investigations point to internal cryptic control over fertilisation by the female. Females were mated to two males, with either a few hours or just over a day between the matings. All flies came from two different lines (Pgm-2, Pgm-3) selected for different alleles of the Pgm locus. I tested for effects of the male's genotype on copulation duration, latency and fertilisation success. The proportion of offspring fathered by the second male (P2) was scored using the Pgm marker. Results indicate that both the male's genotype and his genetic similarity to the female's genotype affected paternity. Paternity of males from Pgm-2 line was overall higher but females at the same time preferred males of a genotype different from her own. Males homozygous for allele 2 (Pgm-2) copulated longer and their latency to copulation was shorter. The experiment showed that female *S. stercoraria* uses cryptic choice to control paternity to overcome her lack of behavioural control.

### MORETTI Marco<sup>1</sup>, HÖRDEGEN Philipp<sup>2</sup>, CONEDERA Marco<sup>1</sup>, DUELLI Peter<sup>2</sup> & EDWARDS Peter J.<sup>3</sup>

<sup>1</sup> Swiss Federal Institute for Forest, Snow and Landscape Research; Station South of the Alps; CH-6504 Bellinzona; Switzerland

<sup>2</sup> Swiss Federal Institute for Forest, Snow and Landscape Research; CH-8903 Birmensdorf/ZH; Switzerland

<sup>3</sup> Geobotanical Institute; Swiss Federal Institute of Technology; Zürichbergstrasse 38; CH-8044 Zürich; Switzerland

#### Response of invertebrates to wildfires. First results about spiders (Araneae) and ground beetles (Carabidae) in deciduous forests on the south part of the Alps (Ticino, Switzerland)

Current knowledge on the consequences of wildfire for faunistic biodiversity is fragmentary, particularly in deciduous forests south of the Alps, which is the region of Switzerland most affected by this phenomenon. After the second year of a doctoral thesis about "The influence of sporadic and regular fires on invertebrate biodiversity" planned for three years, we present some preliminary results. The aim of the project is to explore the effect of single and regular fires on the invertebrate fauna. The investigation is taking place in a hilly region in the chestnut belt (*Castanea sativa* forest). The study area is a south facing slope. We have sampled several invertebrate groups in 23 test areas: 7 areas affected by a single fire, 10 areas with repeated



fires and 6 control areas of intact forest. The soil fauna have been assessed using several standardised sampling methods: pitfall traps for epigeic arthropods, litter-soil samples and soil electors for soil dwelling groups, and yellow window traps for flying insects. Sampling period between January and October 1997. The first results show that among spiders and carabid beetles species react differently to fire. Some species of spider are already present a few days after the fire; however, other species seem to avoid burned areas. The highest number of species of spiders was recorded in 2 years old burned areas. The number of species of carabid beetles appears to be higher in forest areas which have burned frequently. Some first hypotheses based on these preliminary results are presented.

### MÜLLER Jürg P.

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The reintroduction of the Bearded Vulture, *Gypaetus barbatus*, in the Alps – an example for the practical project realisation

Due to a large-scale reintroduction project the first Bearded Vulture, *Gypaetus barbatus*, released into the wild are breeding again in the Alps, 100 years after their extinction. The project, which has been successful up to now, has the following milestones: the development of a breeding program, the choice of a suitable means of release, the choice of four release sites in the Alps as well as the establishment of a monitoring program.

Of great importance was the setting up of the breeding network and the decision not to take any animals from the endangered populations. Therefore, only a breeding program with about 50 birds, already in captivity and belonging to the Eurasian sub-species *Gypaetus barbatus barbatus* could be considered. Breeding stations were established in Vienna, Haute-Savoie and Goldau. For the breeding program additional pairs are kept in different zoos.

Today the breeding program functions very well. About 150 birds were brought up in captivity. 50% were set free, 50% were taken into the breeding stock.

A further decisive step was the choice of the method for release. Using the so-called "Hacking method", the birds are brought at an age of about 100 days without parents into an artificial nesting site. At that time, they are not able to fly, but start flying usually 20 days later. During this period the birds get a strong connection to the release site: a behaviour also called philopatry.

The choice of 4 release sites, distributed at regular intervals across the Alps, has a strong bearing on the release method. It is expected that the birds, because of their philopatric behaviour will, in the majority of cases, stay in the range of their release area and preferably hatch there. In this way, nuclei of populations are created from which a whole population can build up in the Alps.

The next step was to draw up a monitoring project: Monitoring is understood as the comparison of the target situation, i.e. a self-sustaining population in the Alps, with the present situation at a certain point in time. As long as these situations differ from each other, the project should be continued. In detail, monitoring also serves to discover wrong developments and therefore wrong decisions. So the monitoring program encompasses a whole range of scientific projects.

At the present time following scientific programs are being carried out in the Swiss project:

The spread of the birds over the Alps and their survival is monitored with the help of amateur field observers such as ornithologists and game guards, reporting their sightings to the project data bank.

The development of the young at the release sites and the formation of pairs is followed up by zoologists, charged by the reintroduction project.

The fact of small populations both in the breeding network and in the wild, require a genetic management plan. The basic study is carried out by Barbara Gautschi from Zurich University.

I would be wrong to believe that the monitoring program allows us a very precise regulation of the project. If the breeding methods were unsuitable and the birds would not hatch in the wild then one would have to rethink the whole project entirely. Monitoring also has an important

documentary and scientific value. In this way one can follow the establishment of a population in a previously uninhabited area.

Up to now 80 birds have been released, of which about 50 survived. Breeding of released birds took place in Haute-Savoie (1997 and 1998) and in the Stelvio National Park (1998). There, the birds obviously have started breeding again; so that there is much hope they will reproduce also this year.

In a reintroduction project spanning the whole region of the Alps and crossing country borders, great observance had to be given to the internal flow of information. An own bulletin, annual meetings and workshops serve to train the people involved. The public relation work proves an extremely important feature. It is prerequisite for the acceptance of the project by the population and the authorities (permission) and for successful funding. Contributions to television, radio and printed media are decisive to the project becoming well known. Books, brochures and exhibitions have a long term educational effect while lectures are suited to winning over local interest groups (local population, hunters, authorities, ornithologists) and to discussing criticism of the project.

A difficult exercise in managing the project besides the specific expertise problems is the leadership of the many different persons involved. Many take part for very different reasons and therefore have very different expectations of the project.

In order to carry out this sort of project and to make the necessary decisions, information of various types are needed: practical knowledge about keeping animals, results of specially initiated basic research, studies with the characteristics of environmental impact assessments, extensive and intensive monitoring, project management and public relations.

Zoologists who want to take part in such projects need more and better-organised opportunities for practical training and for further education in addition to their purely scientific field.

**OERTLI Beat, AUDERSET-JOYE Dominique, JUGE Raphaëlle, CASTELLA Emmanuel, MÜLLER Jessica, ANTOINE Céline, SAAM Mirko, CAMBIN Diana & LACHAVANNE Jean-Bernard**

Laboratoire d'Ecologie et de Biologie aquatique; University of Geneva; chemin des Clochettes 18; CH-1206 Genève; Switzerland

#### Biodiversity in Swiss ponds: how biotic communities respond to altitude

This large-scale project supported by the Swiss Federal Office for Environment, Forest and Landscape is an investigation of environmental conditions and biodiversity over a wide range of small waterbodies. It aims at: (1) categorising waterbodies and their associated plant and invertebrate diversity, (2) deriving predictive relationships between a set of environmental characteristics of the ponds (structure of the environment, water quality ...) and their biotic richness and composition, (3) setting up a standardised method for the assessment of the conservation value of ponds. The first results demonstrate the preponderance of altitude in governing diversity of Swiss ponds and a quantification of this tendency is proposed. Altitude also plays a key rule in the typology of the ponds.

**OLIVIERI Isabelle**

Institut des Sciences de l'Evolution; Université Montpellier 2; place Eugène Bataillon; F-34095 Montpellier cedex 05; France

#### Contribution of metapopulation-level studies to the understanding of extinction, adaptation, and speciation

The evolutionary potential of a species is of primary concern in conservation biology. Such evolutionary potential may be described by the genetic and phenotypic diversity of a species, its colonising ability, as well as by its propensity to locally adapt and eventually speciate. Clearly, studies above the population-level are a necessary step towards an understanding of what

determines a species niche breadth. In this talk, I will describe how the evolution of dispersal might affect the evolutionary potential of a species, by taking examples from widespread and endemic plant species. I will then describe how the evolution of dispersal and habitat selection through host choice can lead to local adaptation and eventually speciation in herbivorous insects. Methods used range from mathematical models to demographic surveys of natural populations, through population and quantitative genetics studies.

### **PASCHKE Melanie**

Institut für Umweltwissenschaften; Universität Zürich; Winterthurerstrasse 190; CH-8057 Zürich; Switzerland

#### **Does genetic variation matter ?**

The theoretical background of loss of genetic variation in small populations of plant species is well discussed. Reduced genetic variation is thought to decrease the future capability of a population to adapt to environmental changes. However, theoretical predictions so far have not been critically evaluated in the field. It is still unclear if under stressful environmental conditions genetic variation in itself is more important for the survival of a population than the phenotypic plasticity of the individuals. The hexaploid *Cochlearia bavarica* (Brassicaceae, Vogt 1985) is endemic to Bavaria and highly endangered. It is a perennial, self-incompatible plant. In a previous study a reduced genetic variation and reproduction was observed in small populations of the species. In the present study I now ask the following questions: 1) Is high genetic variation within populations important for plant performance in the field and is this relationship independent of population size ? 2) Is high genetic variation within populations important for the coping with environmental stress ? I carried out two experiments to address these questions: transplantation experiment: performance of plants in own/foreign environments.

### **PASINELLI Gilberto**

Zoological Museum and Institute; University of Zurich; Winterthurerstrasse 190; CH-8057 Zürich; Switzerland

#### **Effects of habitat structure on home range size and breeding success of the middle spotted woodpecker *Dendrocopos medius***

The endangered middle spotted woodpecker is restricted to old oak forests, which are rapidly disappearing due to inappropriate forest management. The relationships between habitat factors, home range size and breeding success of this species was investigated during a five year study based on 33 radio-tracked birds. Multivariate analyses revealed that home range size was inversely related to a) the density of potential cavity trees and b) three variables potentially linked to food supply, namely the densities of large oaks ( $\geq 36$  cm dbh) and rough-barked trees as well as the amount of dead limbs in crowns. None of these four variables was related to breeding success, suggesting that the middle spotted woodpecker adjusts home range size to habitat quality. Management decisions in favour of this woodpecker should not only focus on the conservation and promotion of large oaks, but also on the supply of trees suited for cavity excavation.

### **PASTORINI Jennifer<sup>1</sup>, FORSTNER Michael R. J.<sup>2</sup> & MARTIN Robert D.<sup>1</sup>**

<sup>1</sup> Anthropologisches Institut; Universität Zürich; Winterthurerstrasse 190; CH-8057 Zürich; Switzerland

<sup>2</sup> Florida Atlantic University; Division of Science; Dept. of Biology; 2912 College Avenue; Davie FL 33314; USA

#### **Phylogenetic relationships among Lemuridae (Primates) inferred from DNA sequences**



The family Lemnaceae includes 4 genera: *Eulemur*, *Haplemur*, *Lemur*, *Varecia*. Phylogenetic trees based on morphology generally place *Haplemur* as the most basal offshoot. By contrast, genetic and behavioural studies have consistently placed *Haplemur* as the sister-group to *Lemur*, with *Varecia* as a basal offshoot. Nodal relationships among *Eulemur* species also remain contentious. A mitochondrial DNA sequence data set from the ND3, ND4L, ND4 genes and 5tRNAs (Gly, Arg, His, Ser, Leu) was generated to try to clarify phylogenetic relationships within the Lemnaceae. We extracted DNA from hair, blood or tissue samples from all species of all four lemurid genera and various outgroup taxa were also included. The ~2400 bp sequences were analysed using maximum parsimony, neighbour-joining and maximum likelihood. The results support a basal position for *Varecia*, a sister-group relationship for *Lemur/Haplemur* and monophyly of *Eulemur*, but relationships among *Eulemur* species were not clearly resolved. One clade contains *mongozi*, *rubriventer*, and *fulvus*; *macaco* and *coronatus* form the second clade. *H. griseus* and *H. aureus* form a clade with strong support, but the sequence data do not yield resolution of the trichotomy involving *H. simus*, *H. aureus/H. griseus* and *L. catta*. Pairwise distances among all 4 taxa are approximately equal; there is no increase in genetic distance between *Lemur* and *Haplemur*. Although our preliminary results do not definitively show whether *Haplemur* is paraphyletic, they do at least strongly support a sister-group relationship for *Lemur* and *Haplemur*.

**PERRET Mathieu, SAVOLAINEN Vincent, CHAUTEMS Alain & SPICHTER Rodolphe**

Conservatoire et Jardin botaniques de la Ville de Genève; chemin de l'Impératrice 1; CH-1292 Chambésy; Switzerland

**Pollination systems and speciation in Sinningieae (Gesneriaceae, Angiosperm)**

In angiosperms, plant-pollinator interactions have been suggested to play a major role in speciation, but few studies have addressed how such ecological relationships originate and evolve. In the present study, we have chosen a phyletic approach in the plant tribe Sinningieae. These herbaceous/shrubby plants from the Neotropics are pollinated by bees, butterflies, moths, hummingbirds or bats. The major question that we address is how speciation occurs at the plant-animal interface, viz. how pollination systems versus allo/sympatry took part in the diversification process of these gesneriads. For this purpose, we inferred the phylogeny of all plant species (75 sp.) using DNA data from three noncoding regions of the plastid genome (trnL-trnF, rbcL-atpB and rpl16). In addition, since sugar ratios have been correlated with pollinator identity, nectar has been collected and analysed. These rewards, together with the morphological syndromes, have been mapped onto the phylogeny to trace the evolutionary events that should have given rise to the modern distribution of ecological features. In the case of species with a wide geographical distribution, we show how sympatric speciation could have occurred with pollinator switches. By contrast, in the case of clades containing species with the same pollinator, we show that speciation has relied on geographical isolation or minute morphological specializations to specific pollinators. Finally we discuss complementary approaches (population/field experiments, developmental genetics) that will be developed in the near future.

**PERRIN Nicolas, BALLOUX François & GOUDET Jérôme**

Institute of Ecology; Biology Building; University of Lausanne; CH-1015 Lausanne; Switzerland

**Breeding systems inferred from genetic structures**

We investigate the possibility to infer the parameter values of breeding systems (number and size of breeding groups within subpopulations, sex-specific dispersal, polygyny level) from field estimates of the amount and apportionment of genetic variance (hierarchical Fst). The approach is illustrated for the case of *Crocodylus russula*, a monogamous shrew with female-biased dispersal.



**PFLUGSHAUP Kaspar & KOLLMAN Johannes**

Geobotanisches Institut ETH; Zürichbergstrasse 38; CH-8044 Zürich; Switzerland

**Reproductive traits in small and isolated populations of *Prunus mahaleb***

At the margin of its distribution in central Europe *Prunus mahaleb* is confined to steep, south-facing cliffs and scree slopes which have a particular sunny and warm microclimate. The fleshy-fruited shrub is widespread in the Mediterranean basin and extended its area of distribution towards central Europe during a warmer period after the last glaciation. Thus, the relictic populations in central Europe have been isolated for about 5,000-6,000 years. To investigate the effects of isolation and population size on reproduction of *P. mahaleb* several flower and fruit traits were sampled in eleven small and isolated populations in Switzerland. Mean fruit pulp mass and seed mass were tightly correlated across all populations, and positively correlated with flower size. Flower size, pulp and seed mass correlated neither with population size nor with the degree of isolation. However, the three variables showed a significant negative correlation with the altitude of the study sites. In a Principle Component Analysis (PCA) seven of the populations were clearly differentiated by their reproductive traits. The first axis of the PCA was mainly determined by flower size, pulp and seed mass; this axis ran parallel to a gradient in precipitation. The second and third axes correlated with the number of flowers and fruits per raceme, and percentage abortion of immature fruits within the racemes. These results suggest that climatic factors are more important to explain the observed variation in flower and fruit traits than population size or the degree of isolation.

**PULFER Corinne, OERTLI Beat, CASTELLA Emmanuel & CAMBIN Diana**

Laboratoire d'Ecologie et de Biologie Aquatique; University of Geneva; chemin des Clochettes 18; CH-1206 Genève; Switzerland

**Biodiversity of Trichoptera in Swiss ponds**

Within the framework of a larger project aiming at the classification of ponds in Switzerland and the set up of an assessment method for the conservation value of these ecosystems, larval Trichoptera assemblages were surveyed in 56 ponds varying in altitudinal range, morphometry and nutrient status. Sampling was carried out on a habitat basis, accounting for all the major habitat types occurring in the ponds. Relationships between the occurrence of the 35 taxa found and a set of environmental variables (structure of the pond surrounding, water quality) are presented. They stress altitude as a prominent constraint for the prediction of trichopteran diversity.

**REUTER Max & KELLER Laurent**

Institute of Zoology and Animal Ecology; University of Lausanne; Bâtiment de Biologie; CH-1015 Lausanne; Switzerland

**Conflict over caste determination in eusocial hymenoptera**

Haplodiploidy makes that in the eusocial hymenoptera workers favour a female-biased sex ratio whereas the queen prefers an equal investment in male and female sexuals. Although both workers and gynes develop from female eggs (caste determination occurring during the larval stage), we show in a simple model, that the evolutionary stable (ES) investment in workers for the queen and the workers do not differ, if the number of female eggs available is not limited. In this case, workers are not produced at the expense of gynes. Introducing a constraint on the adult sex ratio (gynes and workers to males) in our model, we find that the workers' ES investment in worker production is lower than that of the queen. At the workers optimum, overall sexual production (a function of investment in workers) is smaller than at the queen's ES strategy (ESS), but the sex ratio is more female biased. If worker-gyne determination is under control of the developing larvae themselves, the ES investment in workers is slightly

lower than at the workers' ESS. Our results indicate that considerable conflict over caste determination arises between the queen on one hand and the workers and female larvae on the other. Worker-larvae conflict, in contrast, is almost insignificant.

### **RIBI Georg**

Zoologisches Museum der Universität Zürich; Winterthurerstrasse 190; CH-8057 Zürich; Switzerland

Habitat alterations facilitate genetic introgression between European *Viviparus* species (Mollusca, Prosobranchia)

*Viviparus ater* lives in lakes and rivers, whereas *V. contectus* originally lived in semi-permanent swamps, ponds and small streams. However, swamps have been drained throughout Europe and *V. contectus* has lost most of its preferred habitats. On the other hand, new habitats such as canals and harbours have been created which are suitable to both species, and where they now live sympatrically. Since *V. ater* and *V. contectus* have been found to coexist only in disturbed or man-made habitats, it can be assumed that the two species occupied different habitats during most of their evolutionary history, and that it is only now that coexistence between them is widespread. This may also be an explanation for the fact that the two species, despite pronounced differences in many characters, can still hybridise. Hybrids are fertile in backcrosses with both parental species. Natural hybrids and backcrosses were found in Lake Garda, Italy, and electrophoretic data suggest that genetic introgression may occur between *V. ater* and *V. contectus*. Although introgression may have only just started, the high frequency of interspecific copulations in nature, the high survival rate and the high fecundity of hybrids and backcrosses suggests that there is a high potential for introgression. This is an example of genetic changes of natural populations probably brought about by man made habitat alterations.

### **RIGBY Mark C. & JOKELA Jukka**

ETH Zürich; Experimental Ecology; ETH Zentrum NW; CH-8092 Zürich; Switzerland

High costs of predator avoidance compromise immune defences in snails (*Lymnaea stagnalis*)

Organisms are often attacked simultaneously by several kinds of enemies, requiring different defences. The optimal level of defence is a balance between the costs and benefits of defence. However, with multiple enemies, the allocation to one defence may constrain the necessary allocation to another defence. Here, we show that two different defence strategies have substantial interacting fitness costs. We manipulated the allocation to predator avoidance and immune defence in the freshwater pond snail *Lymnaea stagnalis*. Increasing predator avoidance correspondingly reduced energetic reserves, the proportion of snails reproducing, and reproductive output. Immune challenge imposed high costs when predator avoidance was infrequent, but lower costs when predator avoidance was frequent. This suggests that snails trade immune defences for predator avoidance, weakening their ability to defend against parasites when predators are abundant.

### **ROMER Jann**

Zoologisches Museum der Universität Zürich; Winterthurerstrasse 190; CH-8057 Zürich; Switzerland

*Astacus leptodactylus* - a threat to native species in Lake Aegeri, Switzerland ?

Lake Ägeri hosts three crayfish species: *Austropotamobius torrentium*, *Astacus astacus* and *Astacus leptodactylus*. The last species, originally from Eastern and South-eastern Europe, was caught for the first time in Switzerland in 1979. It has a higher reproductive rate and grows

faster than the two indigenous species (*Au. torrentium* & *As. astacus*). To estimate the potential of *As. leptodactylus* to affect indigenous species in Lake Ägeri, I examined the distribution and relative densities of the three species and their association with different substrate types, collecting plot samples by SCUBA-diving. I found crayfish at 29 of 33 sites between April and September 1997. I found only one species at 8 sites, two species at 15 sites and all three species at 6 sites. Species composition differed significantly between sites according to substrate composition. *Au. torrentium* prefers stony substrate, while the two *Astacus* species were more frequent at sites with muddy substrate and reed vegetation. In all three species, I found gravid females and recently hatched juveniles and all size classes were present. Animals missing appendages were more often *As. astacus* than either of the two other species. Limb loss was significantly more frequent in *As. astacus* at sites where the introduced species (*As. leptodactylus*) was present at high densities. This suggests that *As. leptodactylus* is dominant in competitive interactions with *As. astacus* and the potential for competitive exclusion exists.

### **ROULIN Alexandre, KÖLLIKER Mathias & RICHNER Heinz**

Department of Zoology; University of Bern; CH-3032 Hinterkappelen; Switzerland

#### **Hawk-dove games among offspring of *Tyto alba***

Conflicting parent-offspring interactions are among the most common behaviours in both humans and animals. Models of offspring begging propose two possible outcomes of the conflict where either scramble competition among siblings leads to escalated begging level to attract the parents' attention, or where begging is a honest indicator of food need directed at the parents. However, nestlings may also use each other's vocalisation behaviour to decide whether to escalate or retreat in a contest over food, as in a game theoretical model with conditional Hawk-Dove strategies. Following game theory, a nestling should play Dove when a nestmate vocalises more intensely and may therefore be willing to escalate in the contest over the next food item delivered, and he should then increase vocalisation once this nestmate has consumed the prey. Such a change in vocalisation is not predicted by both scramble competition and honest signalling models. All three experiments in wild barn owls *Tyto alba* suggest that nestlings are sensitive to each others vocalisation level in a manner consistent with the conditional Hawk-Dove strategies. The findings suggest that the understanding of parent-offspring conflict may require the incorporation of a game theoretical approach of asymmetric contest into current begging models.

### **ROY Bitty, LANDOLT Martin, GAECHTER Fani & SCHMID Bernhard**

Geobotanisches Inst. ETH; Zürich; und Institut für Umweltwissenschaften; UNI Zürich; Switzerland

#### **Relationships between biodiversity and enemy attack rates**

Theory suggests that disease and herbivory should be more prevalent where plant biodiversity is low, because effective host density is correspondingly high, and high host density should facilitate transmission. To assess this idea experimentally, we quantified disease levels and herbivore attack in the BIODDEPTH experimental plots in Switzerland. Plant diversities per plot were 1, 4, 8, or 32 plant species per plot. Our 1998 data show that of the nine natural enemies studied on three different hosts, 5 were more prevalent in the lowest-diversity plots (in agreement with theory), but 9 were more prevalent in higher-diversity plots (violating the predictions of theory). These results suggest that the individual ecology of each disease or insect must be considered before host diversity levels can be used to predict attack rates.

### **RUSTERHOLZ Hans-Peter & ERHARDT Andreas**

Department of Integrative Biology; Section of Conservation Biology (NLU); St. Johannis-Vorstadt 10; University of Basel; CH-4056 Basel; Switzerland



### Influence of human land-use change on the genetic population structure of the Adonis Blue butterfly (*Lysandra bellargus* Rott)

Today, habitat fragmentation is one of the most important processes causing losses of biodiversity and increasing species extinction rates. Consequently, assessment of population genetic structure and diversity is increasingly relevant for the management for threatened species. In this study, RAPD-PCR analyses are used to investigate the effects of habitat fragmentation on the genetic structure of Adonis Blue butterfly populations in the northwestern Jura mountains. Twelve populations ranging from small (estimated population size: 10-30 individuals) to medium (35-70 individuals) to large (200-500 individuals) were investigated. Our study shows that: (1) genetic diversity and hence molecular variance are reduced in the small populations, and (2) these two measurements do not differ between medium and large populations, (3) molecular variance between populations are high (35%), (4) there was neither a correlation between genetic distances and geographical distances, nor did clustering of the genetic phenotypes correspond to the geographic locations of the study sites, and (5) all investigated populations are highly isolated (range of calculated gene flow between populations:  $1 \times 10^{-4}$  to  $8 \times 10^{-5}$ ). This example shows that man-made changes of landscape can reduce and fragment butterfly populations with the associated genetic consequences. These findings are of particular relevance for conservation, since they suggest that fragmentation of formerly large butterfly populations causes disruption of gene flow and genetic erosion in small relic butterfly populations.

**RYSER Peter, ZOBEL Kristjan, EEK Liina, URBAS Pille & WAHL Stefan**

Geobotanisches Institut ETH Zürich; Gladbachstrasse 114; CH-8044 Zürich; Switzerland  
Department of Botany and Ecology; Tartu University; Lai 40; EE-2400 Tartu; Estonia

### Plant characteristics which drive succession

Artificial grasslands were grown in pots for two years at two levels of irradiance and nutrients. Species mixtures consisted of three combinations of ten ecologically contrasting grass species each. Although the treatments provoked a clear response in growth and plant morphology, there were no differences in species composition of the swards after the first growing season. The proportion of a species in the sward after one growing season correlated negatively with its leaf tissue density and its root tissue density. A low tissue density is known to be associated with a high inherent relative growth rate of a species. Initially dominant species had shorter leaf life-spans and faster root turnover rates. In full daylight the average leaf life-span of the sward increased and the average root turnover rate decreased in the second year due to shifts in species composition. In shade, however, a strong increase of two species with high turnover rates, *Poa trivialis* and *Dactylis glomerata*, counteracted the general increase of species with low turnover rates. We conclude that the initial course of succession is largely independent of environmental conditions. Among the species present at a site, fast growing species with a low tissue density initially dominate the vegetation regardless of irradiance or nutrient supply. These species have shorter leaf life spans and faster root turnover rates, which indicate that their relative abundance would diminish in the course of a succession. However, this was only partly confirmed by the data of the second growing season.

**SALAMIN Nicolas, RUEDI Manuel & SAVOLAINEN Vincent**

Institute of Ecology, University of Lausanne, CH-1015 Lausanne; Switzerland

### Inferring complex phylogenies: which strategy to adopt ?

During the evolution of species, speciation and extinction events were far from uniform. In particular, many groups of organisms experienced rapid diversification known as adaptive radiation. These radiations occurred during short intervals of time, making phylogenetic reconstruction difficult. Moreover, these radiations may happen at different times within the same



organismal history, further complicating reconstruction. Among several possible strategies to overcome such complexities, it is often proposed to combine a rapidly evolving gene (i.e. expected to best resolve recent radiations) with data from a slowly evolving gene (i.e. expected to best resolve ancient radiations). We have investigated this hypothesis by a series of simulations. Sequences evolving at different rates were simulated along a model tree involving a recent and an ancient radiation. Performances of phylogenetic reconstruction were compared for rapidly and slowly evolving genes, analysed separately, or in combination. Even with extensive data sets, neither strategy was completely successful. We then argue for a more refined strategy and test these recommendations with real DNA data sets.

### **SCHIEGG Karin**

Chair of Nature and Landscape Protection; Swiss Federal Institute of Technology; c/o WSL; CH-8903 Birmensdorf; Switzerland

#### **Patch size and patch connectivity: habitat relationships of saproxylic Diptera and Coleoptera**

The intensive forest exploitation during the past centuries almost eradicated dead wood from Central European forests. Species confined to dead wood do not only suffer from habitat destruction but also from the effects of fragmentation. I studied the influence of volume and spatial arrangement of dead wood on saproxylic Diptera and Coleoptera at different scales. Dead wood connectivity was a better predictor of species richness and diversity than dead wood volume. The abundances of saproxylic Diptera and Coleoptera were influenced by the presence of dead wood within 150 m around the traps. Thus, a network of 'dead wood islands' each of about 7 ha in size would be optimal for the effective conservation of saproxylic insects in Central European forests.

### **SCHIEGG Karin**

Chair of Nature and Landscape Protection; Swiss Federal Institute of Technology; c/o WSL; CH-8903 Birmensdorf; Switzerland

#### **Small but beautiful: influence of dead wood dimensions on species richness and diversity of saproxylic insects**

Dead wood is a major component of forest ecosystems providing habitat for a variety of species. The intensive forestry during the past centuries nearly eradicated all dead wood, at least in Central European forests and, as a consequence, the saproxylic fauna depauperated. Efforts made to promote dead wood mostly focus on logs and snags as these are thought to be ecologically more important than branches or twigs. I studied species richness, diversity and species abundance distributions of saproxylic Diptera and Coleoptera reared from logs and branches of beech (*Fagus sylvatica*) using eclectors (emergence traps). In both insect groups, branches hosted more species, more rare and exclusive species and higher diversity than logs. Thus, activities for maintaining and enhancing forest biodiversity must also include the preservation of dead branches.

### **SCHÜRCH Stéphanie, PFUNDER Monika & ROY Barbara A.**

Geobotanisches Institut ETH; Zürichbergstrasse 38; CH-8044 Zürich; Switzerland

#### **Interactions between ants, *Euphorbia cyparissias*, and its pathogenic rust fungi**

Ants form a mutualism with *Euphorbia cyparissias* L. since they disperse its seeds which are specially provisioned with a food body (elaiosome). Ants also make up more than 35% of all visitors to the flowers of *E. cyparissias* and to its parasitic rust fungi (which require insects for reproduction). In this study, we asked whether the mutualism with ants also extends to

pollination of the flowers. In addition, we wondered whether ants fertilised its pathogens as well. A mating system experiment established that *E. cyarissias* can self, but it set more seeds when outcrossed. Insect exclusion experiments showed that ants do pollinate the flowers, but do not fertilise the fungi. Thus ants have positive interactions with the plants and no effect on its pathogens.

### **SOLIVA Marco & WIDMER Alex**

Geobotanisches Institut ETH; Zollikerstrasse 107; CH-8008 Zürich; Switzerland

#### **Phylogenetic relationships within the orchid genus *Ophrys* based on multiple DNA sequences**

The genus *Ophrys* shows a highly specialised pollination system. Flowers imitate female hymenopterans and provoke males to copulate with the flowers. If a male tries to copulate with flowers from different plants, pollination can occur. This type of pollinator exploitation is known as pollination by sexual deceit and is often highly specific. Due to this specificity, strong isolation among plant gene pools should be given. On the other hand, hybrids among species have been reported and morphological boundaries are often blurred. To assess phylogenetic relationships among *Ophrys* taxa, we have chosen DNA sequences from the nuclear and the chloroplast genome. The data set from the nuclear genome (ITS sequences) comprises 706 characters, 34 of which were parsimony-informative for the ingroup. Maximum parsimony (MP) analyses produced 6 shortest trees. The strict consensus tree contains 3 polytomies. The cpDNA data set comprises 978 characters of which 28 were parsimony-informative for the ingroup. Cladistic analyses produced 32.677 most-parsimonious trees. Two polytomies exist in the strict consensus tree. Strict consensus trees based on nuclear and chloroplast DNA sequence variation are largely congruent. One apparent difference between the two trees is the position of the *O. fuciflora* complex. According to the ITS sequences they form a separate lineage. In contrast, in the cpDNA tree the complexes *O. argolica*, *O. fuciflora* and *O. sphegodes* form a large polytomy. This difference may be due to different levels of variability of the two considered regions. Over all, the large polytomies suggest that most *Ophrys* species have diverged relatively recently.

### **STEPHAN André, MEYER Andrea & SCHMID Bernhard**

Institut für Umweltwissenschaft; Universität; Winterthurerstrasse 190; CH-8057 Zürich; Switzerland

#### **Plant diversity positively affects soil microbial diversity**

Soil microbial diversity is neither easily measurable nor precisely defined. Measurements of potential C-source utilisation by microbial communities can be done with BIOLOG plates. The resulting patterns of C-source utilisation represent an informative projection of the soil microbial community structure. We applied this technique (BIOLOG EcoPlates with 31 C-sources) to soil samples taken from an experiment designed to assess the effects of plant diversity on ecosystem functioning. In this experiment special emphasis was given to true replication of the plant diversity levels and to the influence of the functional groups grasses, herbs and legumes. We found that increasing plant species richness (log-scale) led to linear increases in (1) total soil bacterial activity ( $p < 0.01$ ) and (2) soil bacterial diversity measured by the C-source utilisation patterns (richness  $p < 0.05$ , Simpson-Index  $p < 0.01$ , Shannon-Wiener index  $p < 0.05$ ). More precisely, (3) the microbial activity increased with plant species richness on more than half of the 31 investigated C-sources ( $p < 0.001$  for 3,  $p < 0.01$  for 7,  $p < 0.05$  for 2,  $p < 0.1$  for 4 C-sources), whereas no decline in activity was found for any C-source. Furthermore, (4) soil microbial activity linearly increased with increasing number of plant functional groups ( $p < 0.01$ ). Finally, (5) the three plant functional groups differentially stimulated the soil microbial activity in the order legumes > herbs > grasses ( $p < 0.05$  for 3,  $p < 0.01$  for 2,  $p < 0.001$  for 1 of the 31 C-sources).

**STUDER Sibylle<sup>1</sup>, EDWARDS Peter J.<sup>2</sup> & MEISTER Erhard<sup>1</sup>**

<sup>1</sup> Swiss Federal Research Station for Agroecology and Agriculture; Reckenholzstrasse 191; CH-8046 Zürich; Switzerland

<sup>2</sup> Geobotanical Institute ETH Zurich; Zürichbergstrasse 38; CH-8044 Zürich; Switzerland

**Enhancing biodiversity in agricultural grasslands: plant community structure under different managements**

We are studying the effects of different management systems and of landscape structure on insect (true bugs) and plant diversity in grasslands. This poster focuses on plant community structure of differently managed grasslands. The study site is an area of some 3.5 km<sup>2</sup> in the Schaffhauser Randen in Northern Switzerland. The three administratively recognised management types are: extensive (no fertiliser, one cut), little intensive (little manure addition, two cuts) and medium intensive (moderate fertilisation (mineral or manure/slurry)). For each management type plant species composition has been assessed in twelve locations (replicates). As expected, species richness was highest in extensively used meadows (42 species per 6 m<sup>2</sup>) and lowest in the medium intensive type (30 species per 6 m<sup>2</sup>). The little intensive type was intermediate (35 sp. per 6 m<sup>2</sup>). However, in the ordination analysis (CA) the little intensive type clearly forms a separate group. The results concerning community structure (discussed below) also emphasise the special position of this grassland type. The dominance structure in the little intensive type differs considerably from the other two. In contrast to the extensive and the medium intensive types, the rank abundance distributions of the little intensive type show no clearly dominant species. Furthermore, rank consistency of the 10 most abundant species is lowest in the little intensive type. This means that a relatively large number of species can reach intermediate to high cover values and that a broad range of species can survive in these habitats. We conclude that the little intensive grassland type is of importance and that further work is required to assess its value for conservation of biodiversity in grasslands.

**SUTER Werner**

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**A biodiversity strategy as a national nature conservation concept**

Nature conservation today is in transition from the period, when action meant mainly reaction, to a new era of planned conservation as an integral part of land-use activities. Since there is little difference between nature and biodiversity conservation, the mandate from the convention on biological diversity (Rio de Janeiro 1992) to prepare and implement national biodiversity strategies should be taken by the member countries as an opportunity to develop comprehensive plans for nature conservation. Using Switzerland as an example of the many countries which have not yet embarked on preparing such a strategy, it is argued that monitoring schemes, no matter how good they are, cannot substitute for genuine conservation strategies, but should be seen as instruments for measuring their success. Conservation biology should play a stronger role in the process leading towards a comprehensive national conservation plan. There will be a number of elements central to such a strategy: 1) To define the national role in conserving biodiversity. 2) To state the main goal of the strategy (e.g. conservation of net species numbers). 3) To define target entities of the strategy at different levels (genetic, species, and ecosystems) and the criteria for their measurement (e.g. size of minimum viable populations, minimum size and distribution patterns of biotopes, etc.). 4) To set priorities according to the country's responsibility for species and biotopes. 5) To quantify goals separately for each biogeographical region (habitats ?). 6) To develop ideas of how not only populations and biotopes, but also ecological processes can be conserved, and evaluate where alternative management options (managing the cultural landscape versus letting wilderness develop) are appropriate.



**THURNHEER SYLVIE<sup>1</sup> & ANHOLT BRADLEY R.<sup>2</sup>**

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Higher order interactions: The influence of predator-induced indirect effects on competitive ability in waterfrog larvae (*Rana esculenta* and *Rana lessonae*)

Predators do not only reduce prey density, but also induce behavioural responses in prey species. In waterfrogs, tadpoles of the hybrid *Rana esculenta* and the parental species *R. lessonae*, reduce their activity in the presence of predators. Since the amount of reduction differs between the genotypes, this non-lethal effect of predators can potentially change the competitive ability of their larvae. We investigated this possibility by measuring feeding rates and development for tadpoles of *R. lessonae* and 3 hemiclones of *R. esculenta* in the absence and presence of an odonate predator (*Aeshna cyanea*). At the beginning of the larval period (first month), *R. esculenta* fed and grew more in the presence than in the absence of *Aeshna*, contrary to our expectation. *R. lessonae* fed and grew equally in both treatments. Thereafter, *R. esculenta* reversed the pattern, feeding equally but growing less when *Aeshna* was present. For *R. lessonae* time to and size at metamorphosis did not differ between treatments. In contrast, *R. esculenta* hemiclone GUT3 metamorphosed earlier or hemiclone GUT2 slightly heavier when *Aeshna* was present. This surprising outcome may result from differential reduction of the swimming activity and, hence, energy expenditure of the genotypes. But whatever the mechanism, *Aeshna* predators seem to favour the competitive ability of *R. esculenta*.

**ULLRICH Karin S. & EDWARDS Peter J.**

Geobotanical Institute; ETHZ; Zürichbergstrasse 38; CH-8044 Zürich; Switzerland

Enhancing biodiversity in arable land: the role of management and landscape structure

The intensification of agriculture in Europe within the last decades has led to changes in landscape structure and considerable reduction of biological diversity in agricultural systems. There is now great interest in finding ways of managing such systems to preserve and enhance biological diversity, partly for conservation reasons and partly to achieve greater sustainability. To this purpose the Swiss policy strongly promotes the introduction of ecological compensation areas, such as wild flower strips, set-asides and hedges, in intensively-used arable land. The objective of this study is: 1. To compare the effectiveness of different management schemes in enhancing floristic and faunistic diversity within some of the ecological compensation areas, especially wild flower strips. 2. To examine how ecological compensation areas contribute to biological diversity at a landscape level. The abundance and diversity of plants and insects (Heteroptera) in wild flower strips is being compared and interpreted in terms of the management and the landscape structure. In particular interest focuses on the contribution of spontaneously appearing species. An experimental approach has been used to investigate the importance of dispersal processes and the data will be modelled using GIS.

**UTELLI Anna-Barbara & ROY Barbara A.**

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Altitudinal variation in nectar robbery in *Aconitum lycoctonum*

Studies of nectar robbery have shown that positive, neutral and negative effects on reproduction of the plant can be found. Only few studies also considered the possible geographic variation in the plant-nectar robber interaction. We examined the causes and consequences of nectar robbery in *Aconitum lycoctonum* in high (2000 m) and low (500 m) elevation populations in



Switzerland. At high elevation, nectar robbery was more frequent and was caused by short-tongued bumblebees. A nectar robber exclusion experiment showed that nectar robbery by short-tongued bumblebees had no effect on plant female reproductive success. This result can be explained by the fact that robbing bees rarely damaged the nectaries, and piercing does not decrease flower longevity. In addition, we found that about 10% of the visits these bees made were pollen collecting. Thus, these bees may act as low efficiency pollinators and may at times be mutualistic associates, not just robbers. At low elevation, the holes in the flowers were probably caused by beetles (*Meligethes viridescens*). These beetles are mostly pollen eaters, and as such reduce plant male fitness. In addition, they damage ovaries and nectaries when feeding. Overall, our results show that there can be strong geographic variation in nectar robbery, in the nectar robber community, and the consequences of robbery for host plant fitness.

### VIETTE Michèle, TETTAMANTI Chiara & SAUCY Francis

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#### Preference for acyanogenic white clover (*Trifolium repens*) in the vole, *Arvicola terrestris* in simple and repeated choice tests

In this paper we report investigations on the defensive role of plant secondary compounds in the reciprocal interactions between the vole, *Arvicola terrestris*, and its preferred food item *Trifolium repens*. In white clover, the production of cyanogenic glycosides (liberating HCN when the plant is attacked) is controlled by a simple genetic system involving two diallelic genes. The maintenance of a polymorphism for cyanogenesis in natural populations of white clover is poorly understood and could be explained by a selective pressure of herbivores on different cyanotypes. In this study, we conducted two series of cafeteria tests during which the voles were offered two bunches of white clover. In simple choice tests, 181 animals were tested in 13 combinations using six varieties of *T. repens* (3 acyanogenic and 3 cyanogenic). When offered opposite cyanotypes, they showed a strong preference for the acyanogenic plants, while no significant preference could be detected in tests with similar cyanotypes. However, in the latter case, they ate significantly more in tests with acyanogenic varieties. In repeated choice tests, 40 voles were tested 8 times at one or two weeks intervals for a particular choice in order to investigate the constancy of their behaviour. Again, voles showed a significant preference for acyanogenic plants and most of them showed constant choices. The consequences of these results for the maintenance of polymorphism for cyanogenesis in *T. repens* will be discussed.

### VORBURGER Christoph & RIBI Georg

Zoological Museum; University of Zürich; Winterthurerstrasse 190; CH-8057 Zürich; Switzerland

#### Mechanisms of impact of the introduced crayfish *Pacifastacus leniusculus* on the native crayfish *Austropotamobius torrentium* in Switzerland

Interspecific behavioural interactions by which the introduced North American crayfish *Pacifastacus leniusculus* could affect and possibly displace the native crayfish *Austropotamobius torrentium* in Europe were studied. We conducted a series of laboratory experiments on substrate selection, aggressive interactions and competition for shelter, and we compared size and growth between species. In choice experiments the two species differed in substrate preference with *A. torrentium* mainly selecting gravel and *P. leniusculus* mainly mud. Neither species was inherently dominant in antagonistic interactions, but dominance was size-dependent, favouring the larger and faster growing species *P. leniusculus*. Shelter possession was generally determined by aggressive dominance, although *A. torrentium* showed a stronger preference for shelters and sometimes defended them against larger *P. leniusculus*. Experimental *P. leniusculus* were infected with the crayfish plague fungus *Aphanomyces astaci*, to which they are resistant.

During the experiments, the disease was transmitted to non-resistant *A. torrentium*, which died 10 to 20 days after contact with *P. leniusculus*. We conclude that antagonistic interactions could play an important role in species replacements among crayfish by determining access to limited resources. However in the present case, a crucial factor which may promote an eventual species replacement is the crayfish plague.

### VOUILLAMOZ José

Institute of Ecology, Systematic Botany and Geobotany; University of Lausanne; CH-1015 Lausanne; Switzerland

The genus *Onosma* (Boraginaceae) in Switzerland: chromosome numbers, allozymic polymorphism and evolutionary history of a group of rare taxa

The genus *Onosma* is represented in Switzerland by two rare species distinguished by the numbers of rays (0-20) arising from the base of the main setae, showing distinct chromosome numbers: *O. pseudoarenaria* Schur s.l., with stellate setae (5-20 rays), and *O. helvetica* (A. DC.) Boiss. with simple setae (0-5 rays). The populations of *O. pseudoarenaria* Schur s.l. are split up and located only in Valais, between Martigny and Sierre, and show  $2n=26$  or  $2n=28$ , depending on the presence of B chromosomes. They reveal bimodal chromosomal complements with 12 large (L) and 14 or 16 small (S) chromosomes. The populations of *O. helvetica* (A. DC.) Boiss. form two poles on both sides of those of *O. pseudoarenaria* Schur s.l., one in Ollon (VD) and the other in Haut-Valais, between Sierre and Brig. They both show  $2n=20$  presenting bimodal chromosomal complements (12 L + 8 S) as well. The caryological comparison of these two species with those from Italy (*O. echioides* agg.  $2n=14$  S) and France (*O. fastigiata* s.l.  $2n=12$  L) suggests the hypotheses of an allotetraploid origin for *O. pseudoarenaria* Schur s.l. and of a hybrid origin for *O. helvetica* (A. DC.) Boiss. through back-crossing. These hypotheses are under investigation using starch gel electrophoresis to analyse the allozymic variability and try to confirm or invalidate the putative parent species. Along with the clarification of their exact karyograms, these data may allow to put forward both the origins and the postglacial recolonization routes of the genus *Onosma* in Switzerland.

### WALTHER Gian Reto

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Why palms in Switzerland ?

The present vegetation in a given site is coupled with the local climatic and edaphic conditions. Changes in climate may also cause changes in the species composition of the vegetation. The presented study analyses possible causes of vegetation changes. Especially the spreading of exotic evergreen broad-leaved shrub and tree species points to a possible link with the changing climate in recent times.

### WEIBEL Urs

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Nest site selection and breeding success of skylarks (*Alauda arvensis*) in an arable landscape with wild flower strips

Modern intensive farming regimes in Central Europe have led to severe decreases in skylark populations in the last few decades. The lack of sufficient nesting habitats throughout the breeding season due to the more frequent applications of fertilisers and a restricted crop rotation led to a reduction of the breeding attempts. Additionally, brood losses caused by farming operations, mainly mowing, led to a not sustainable breeding success. In a four year

survey of a skylark population in the Klettgau region (Canton Schaffhausen, northern Switzerland) nest site selection and breeding success was investigated. The study site (5.3 km<sup>2</sup>) is mainly used for intensive winter cereal farming, but the fields are small and wild flower strips ("Buntbrachen") are established on 6 ha. The breeding success was calculated with the May-field method. Throughout the breeding period skylarks showed a shift from winter cereals towards root vegetables as nesting sites, according to the vegetation structure. Wild flower strips, set-asides and cultivated grassland had the highest relative use as nesting habitat. Nests were more often found near to the border of the fields. The daily survival rate of eggs was significantly higher than that of nestlings. The estimated breeding success probability was about 20% between 1995 and 1997, but 38% in 1998. Broods in cereals reached the highest success probabilities, and that of nests in wild flower strips was mediocre. Nests near to the field border had a lower daily survival probability. Predation caused about 70% of all nest losses.

**WEISSER Wolfgang W.**

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**Predator-induced morphological shift in the pea aphid**

Aphids exhibit a polymorphism whereby individual aphids are either winged or unwinged. The winged dispersal morph is mainly responsible for the colonisation of new plants and, in many species, is produced in response to adverse environmental conditions. Aphids are attacked by a wide range of specialised predators and predation has been shown to strongly influence the growth and persistence of aphid colonies. We reared colonies of pea aphids in the presence and the absence of an adult ladybird and noted the types of morphs that were produced. Winged phenotypes first appeared in the presence of a ladybird more than one aphid generation before they were found in the control. This indicates that aphids responded to the presence of the predator by producing the dispersal morph which can escape by flight to colonise other plants. In contrast to previous examples of predator-induced defence this shift in prey morphology does not lead to better protection against predator attack, but enables aphids to leave plants when mortality risks are high.

**ZUBER Doris & WIDMER Alex**

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**Intraspecific phylogenetics of the European mistletoe (*Viscum album*) based on nuclear and chloroplast DNA sequences**

The European mistletoe (*Viscum album*) is a widely distributed, hemiparasitic plant species. Currently, three subspecies are recognized which differ in their host preferences. In central Europe, *V. album* ssp. *austriacum* occurs on pine (*Pinus* spp.) and rarely on Norway spruce (*Picea excelsa*); *V. album* ssp. *abietis* is restricted to silver fir (*Abies alba*), while *V. album* ssp. *album* grows exclusively on a wide variety of deciduous trees. Crossinfection experiments reported in the literature suggest that the host-parasite interaction is highly specific, although few successful crossinfections have been observed. The aim of this project was to assess phylogenetic relationships among *Visum album* isolates from different host species to test whether molecular evidence supports the distinction of three host races and to assess their phylogenetic relationships.